Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

OCTOBER 1953

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Just the Ticket!

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ASK OUR MAN! He can give you worthwhile advice as to supply sources and burning methods for the particular coal you need. The efficiency, economy, and cleanliness of B&O Bituminous today will be a revelation!

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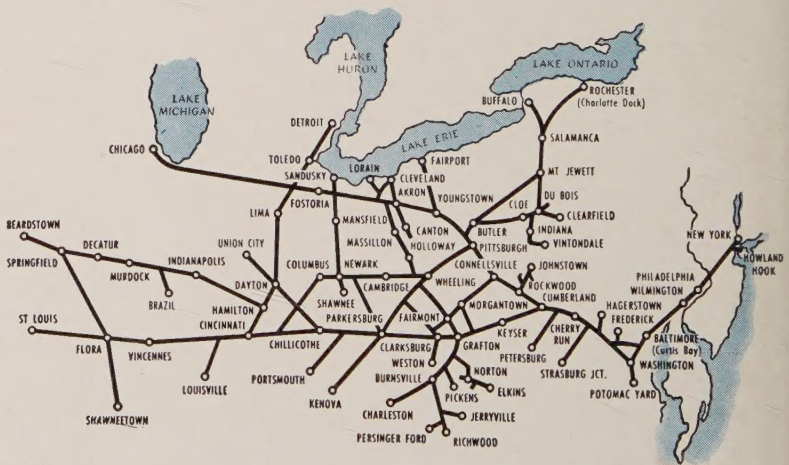

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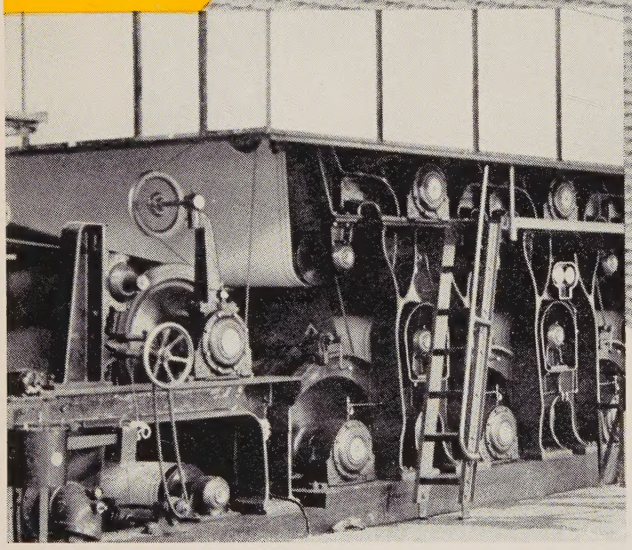
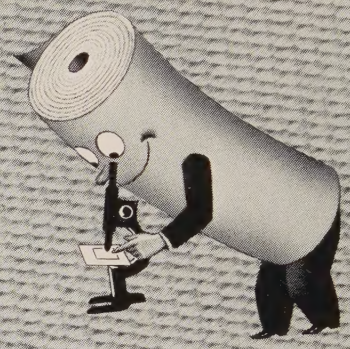
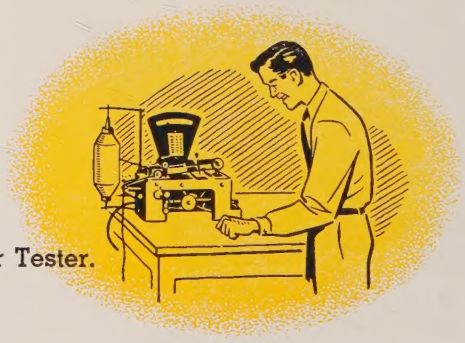
REINFORCED DRYER FELT

Gives You Scientific Construction





*Asbestos yarns woven into the face of Woodberry 887. Clipper Seams if desired.



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4. pH	8. Opacity	12. Moisture
		13. Suspension

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TECHNICAL ARTICLES

Uneven Corrosion in Alkaline Pulping Digesters, *by Francis W. Flynn, Frederick H. Richter and Frederick R. Snyder* 433
Preparation of Hardboard from White Oak, *by S. L. Schwartz* 445
The Isolation of Holocellulose from Wood, *by B. L. Browning and L. O. Bublitz* 452
Effect of Light on Coated Groundwood Papers, *by William K. Wilson and Jack L. Harvey* 459
The Chemical Nature of the Extractives from Red Alder, *by E. F. Kurth and Edwin L. Becker* 461
Centrifuge Analysis for Suspended Solids in White Water, *by E. A. Mason and R. R. Quincy* 467
Pohtographic Measurement of Drainage Rate. A Method for Determining Sheetmaking Rates in Cylinder Machines, *by Charles F. Payne and William Guthrie* 469
An Evaluation of Drying Concepts, *by A. J. Cirrito* 476
Errata—Studies on Modified Cellulose, I, *by Alexander Meller* 480

DEPARTMENTS

Printers' Guide for Paper Purchasing ..... 14 A
Association News and Events ..... 73 A
Personal Mention ..... 84 A
Letters to the Editor ..... 117 A
Recent Books ..... 120 A
Employment Service ..... 121 A
White Water Utilization, *by P. J. Schmitt* ..... 123 A
Building a Library Collection for the Pulp and Paper Curriculum at Western Michigan College of Education, *by T. J. Niemi* ..... 125 A
Some Effects of Extreme Chip Packing in the Sulphite Process, *by A. S. Rosenfeld* ..... 128 A
Fourth TAPPI Coating Conference
Lithography, *by A. P. Reynolds and F. H. Frost* ..... 130 A
Offset Inks for Coated Papers, *by F. J. Dankert* ..... 132 A
Offset Printing of Coated Papers, *by C. F. King* ..... 133 A
Non Paper Factors and Quality of Offset Lithography, *by D. W. S. Riddell* ..... 136 A
Operating Factors in Offset Printing on Coated Papers, *by R. F. Reed and G. Wheeler* ..... 137 A
Coated Paper in Offset Printing ..... 140 A
Coating Experiences with the Champion Coater, *by G. T. Renegar* ..... 148 A
The Role of the Board Machine Calenders in the Mineral Coating of Paperboard, *by H. C. Fisher* ..... 150 A
Considerations in the Installation and Operation of High and Low Solids Coaters in a Board Machine, *by A. W. Pomper* ..... 154 A
Customer Requirements in Coated Boxboard, *by O. M. Curtis, Jr.* ..... 159 A
Coated Board Symposium ..... 160 A
Considerations in the Design of a Universal Coating Machine for Paper and Board, *by R. J. Jacobs* ..... 165 A
Pigmented Size Press Coatings Containing Dow Latex 512K, *by L. H. Silvernail and E. J. Heiser* ..... 172 A
An Approach to the Evaluation of Coated Paper Smoothness, *by L. J. Scheid and A. H. Hupp* ..... 177 A
Progress Report on the Development of a Calcium Carbonate for High Gloss Paper Coatings, *by R. W. Hagemeyer and G. E. Hall* ..... 179 A
Calendar of TAPPI Meetings ..... 183 A

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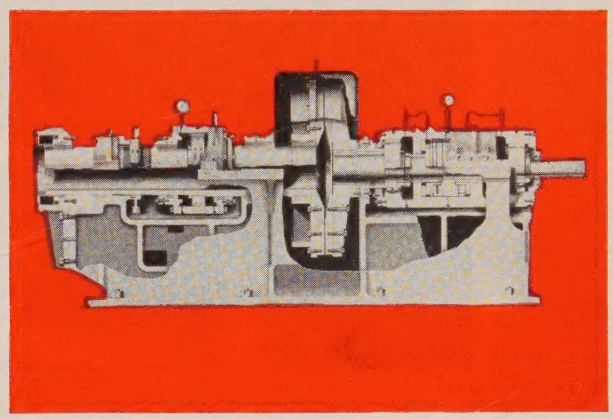

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Why not learn more about how Sutherland Refiners can improve stock preparation operations at your mill? Details of the wide variety of Sutherland applications are furnished in an illustrated folder, available upon request. Write for your copy, today . . . no obligation, of course.

*WE QUOTE FROM AN ARTICLE IN THE PAPER TRADE JOURNAL. A COPY OF THE ARTICLE CAN BE OBTAINED WITHOUT CHARGE BY WRITING TO THE SUTHERLAND REFINER CORPORATION.

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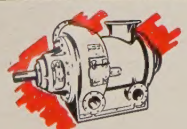

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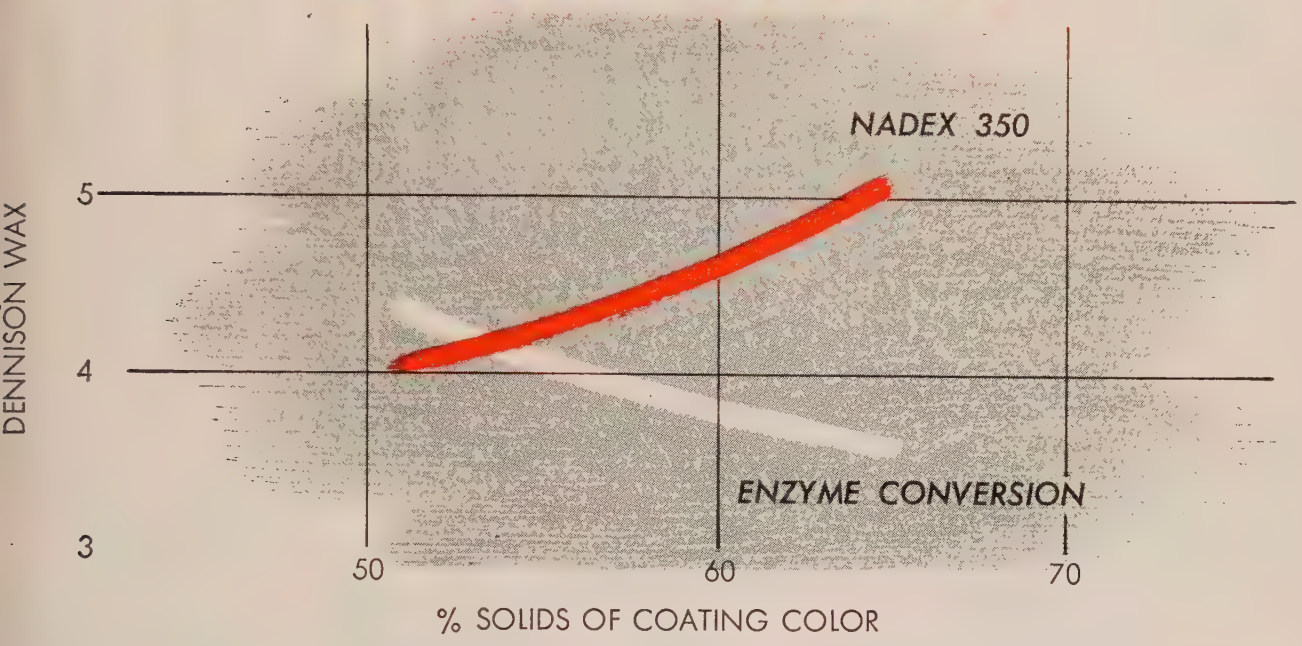

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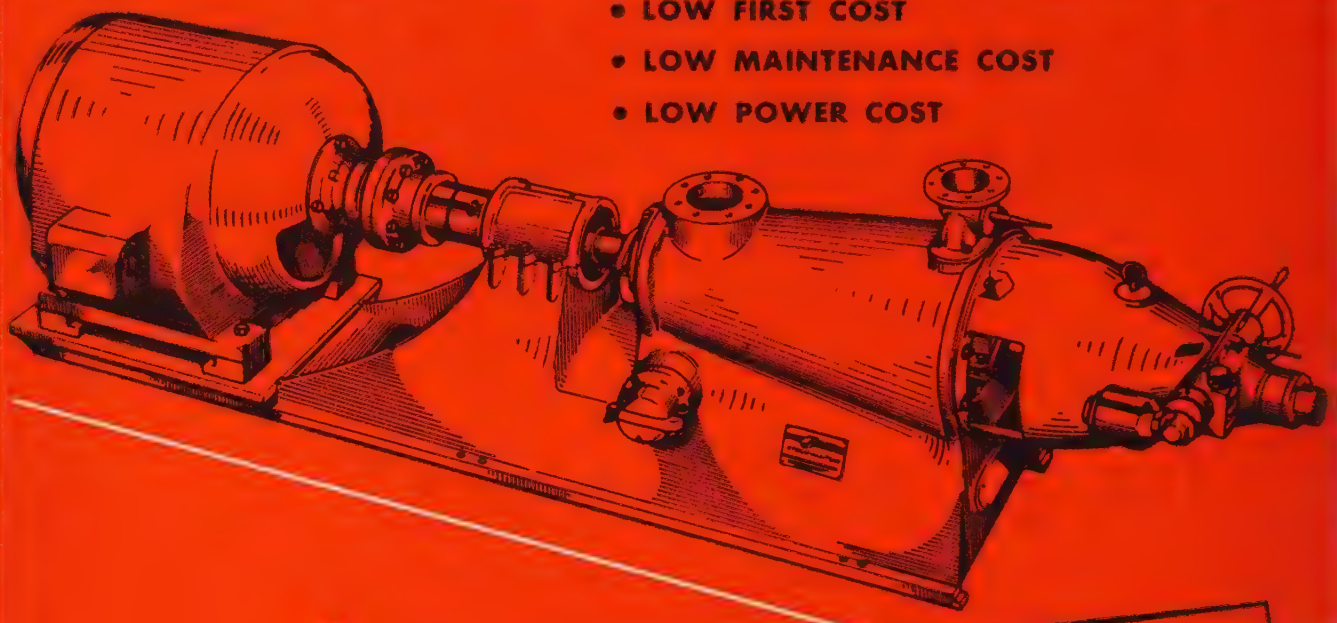

✳ **LOOK AT THE RECORD**

Here's a comparison of the results achieved on the same stock under the same conditions by the STOCKMASTER and a competitive "beater" type refiner.

COMPARATIVE TESTS UNBLEACHED DOUGLAS FIR KRAFT

	Stockmaster 900 R.P.M.	Competitive "Beater" Type Refiner 870 R.P.M.
Speed		1.96
Pulp Quality After Applying 600 HP Hrs./Ton	2.20	325
Fibre Length — MM*	250	6300
Freeness — CC CS	7000	37
Breaking Length — MM	45	144
Burst — Metric	182	
Tear Factor		2.05
Pulp Quality-At 400 CC CS Freeness	2.32	550
Fibre Length — MM*	410	5800
Power Required — HP Hrs. Per Ton	6100	36
Breaking Length — MM	42	172
Burst — Metric	218	
Tear Factor		

*Raw Fibre Length — 2.73 MM

for superior continuous beating

Here's a great new conical refiner — the JONES STOCKMASTER® with range, flexibility, control and *results* to meet your every need.

The wide selection of tackle available, plus precise control of rotor — combined with suitable stock flow, consistency and stock pressure — give the operator a truly flexible and controllable refining machine. The results produced are superior to other types of beating and refining equipment.*

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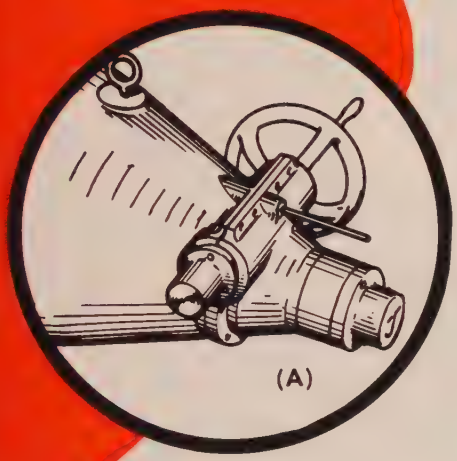
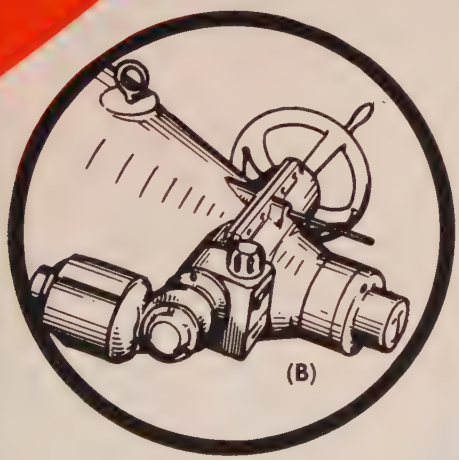


(A)

(A) Standard adjusting mechanism — 10″ hand wheel with worm and worm gear reduction — permits very accurate adjustment of plug position and absorbed horsepower. It is a simple matter to add necessary gear motor and parts to change over to ACCRU-SET control at a later date.



(B)

(B) ACCRU-SET® Control — At modest extra cost, the basic mechanism shown above can be fitted with a gear motor for any desired type of control, from a simple push-button arrangement for remote control to full automatic control of applied power with indicating or recording, current-sensitive or watt-sensitive instruments.

And ask your Jones representative about application of ACCRU-SET to your present refiners.

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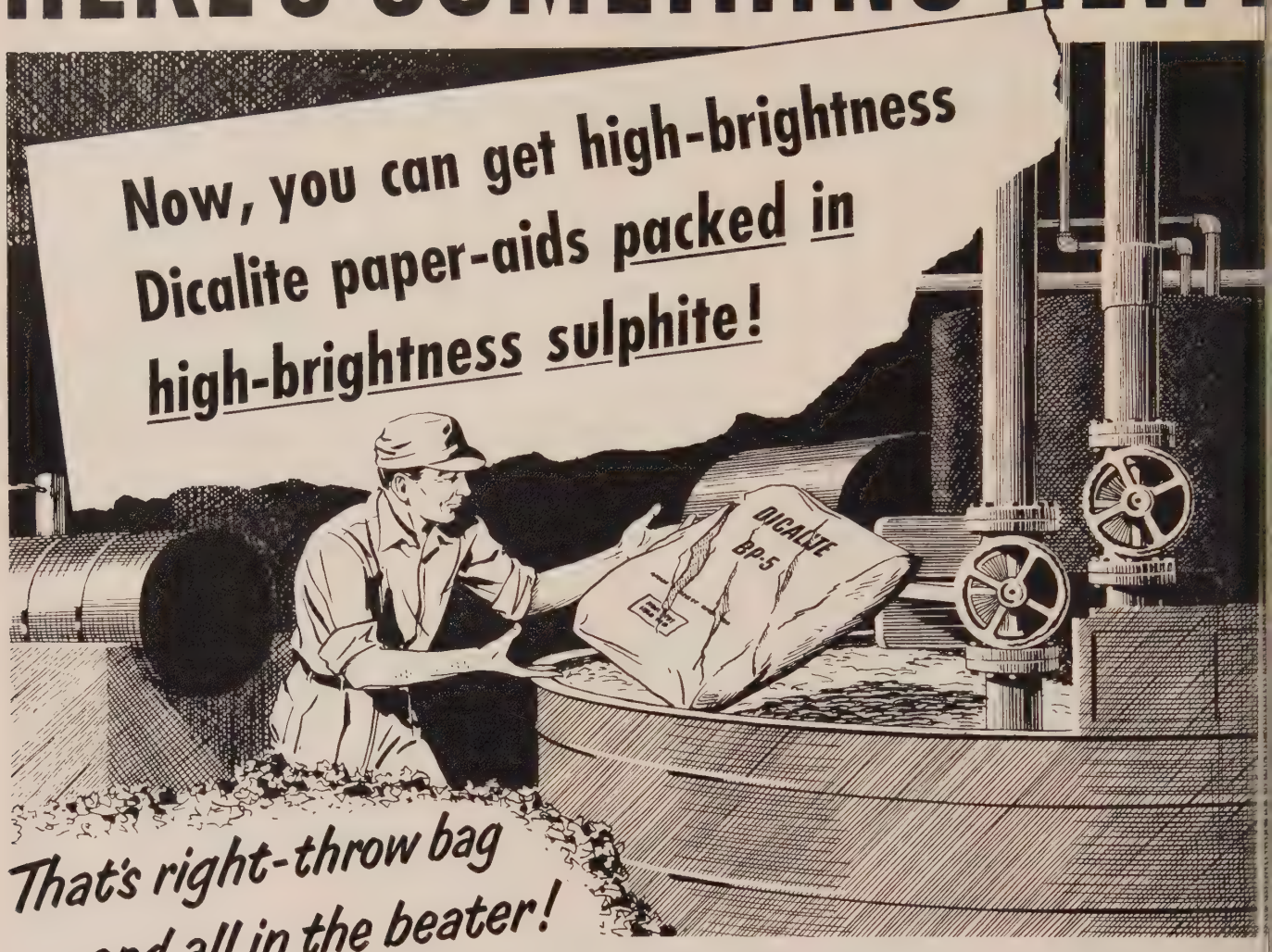
Now, you can get high-brightness Dicalite paper-aids packed in high-brightness sulphite!
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That's right-throw bag and all in the beater!

Dicalite BP-3 and BP-5 are now available packed in bleached white sulphite bags, made with no string sewing, no colored stock of any kind. Even the small amount of labeling is printed in water-soluble ink.

Paper makers tell us this new packing saves time and trouble. Just slit the bag a couple of times and drop the whole thing in – you get high-brightness paper-aid and high-brightness pulp both at the same time. There is a small extra charge for which you receive good white sulphite waste from the bags, plus easier and cleaner handling.

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SEND FOR BULLETIN F-52
Gives data on Dicalite and describes use in paper and paper products

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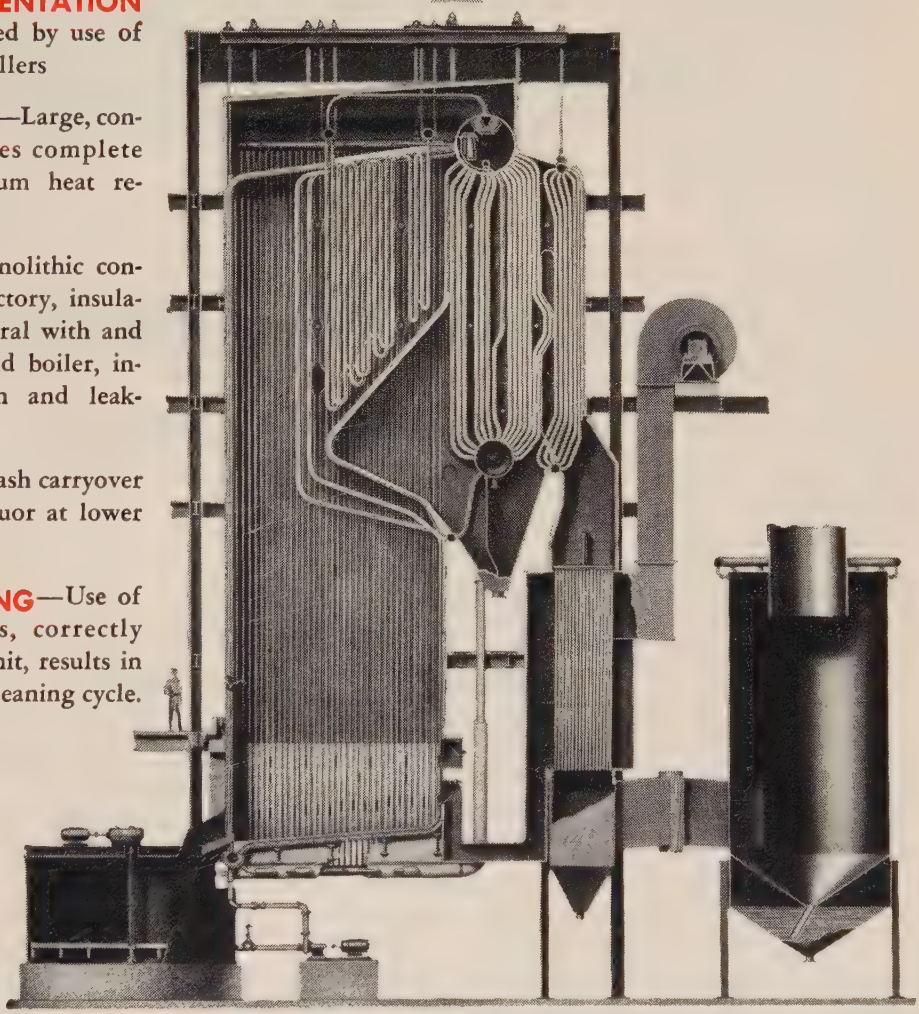

Typical modern B&W Two-Drum Recovery Unit equipped with B&W Cyclone Evaporator.

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PRINTER'S GUIDE FOR PAPER PURCHASING

How to Order Paper Properly

THE LINDENMEYR LIBRARY OF PRINT SHOP HELPS—2

IT IS generally accepted that paper in most commercial printed jobs represents 25% of the total price. That is sufficient reason why the process of buying paper is a major responsibility in print shops. This article tries to reduce the operation of paper buying to a few fundamentals.

HOW TO ORDER PAPER IN SHEETS

All heck broke loose on the receiving platform at Steve Sanders' printing plant. A big, over-the-road trailer-truck backed in with a load of urgently needed book paper packed on skids. Down clanged the tailboard. The long fork-shaped prongs of the hefty lift truck reached for the skid nearest the door. . . .

Came,then, the explosion that almost rocked the building: *the runners of the skids ran the wrong direction.*

When the paper was ordered, that one detail was omitted from the otherwise carefully compounded list of specifications. The commotion, the lost time, the additional handling expense, all added up to grief that could have been easily avoided.

A most unusual occurrence, you'll say—and you're right. Printers don't encounter trouble exactly like that every day. Not even the biggest shops. But, you would be greatly surprised to know how often other forgotten details return to haunt printers.

A successful paper salesman, who admits he "should have known better," shipped four 3000-lb. skids of offset paper into a litho shop in New York when he "knew dern well" the freight elevator in the lithographer's building couldn't accommodate loads heavier than 2000 lb.

There's the equally common case of the printer who doesn't tell his paper supplier that the receiving platform in his building won't accommodate trailer-trucks. True enough, the paper salesman should shoulder some of the responsibility for furnishing that kind of essential traffic information to those on his mill desk. True enough, too, seasoned traffic people are familiar with the facilities and limitations of graphic arts buildings in their markets. They know how to route most shipments most places most economically.

Nevertheless, it isn't fair to expect the paper supplier to guess about such important shipping details. It's only little bother for the paper buyer to write a note of caution like this: "IMPORTANT—*Our receiving platform cannot accommodate over-the-road trailer-trucks.*"

You know the inconvenience of receiving paper packed on single-tier skids when it should have been double-tiered, and vice versa; or, when paper is packed too high on skids, or too low. You know how costs of rehandling can mount, not to mention damage to some of the paper. Yet, it's only after lengthy probing that this vital information is finally written into many orders.

Not long ago a country printer ordered 10,000 lb. of English finish book paper. He specified single-tiered skids—a storage convenience, he pointed out—and let it go at that. He forgot to mention a maximum height. The skid load cleared the outside storeroom doorway easily, but the top of the skid towered over the doorway of the ramp to the pressroom.

When there is more than one white tone in a standard line of papers, or when a special whiteness is demanded, it's surprising how often the paper man must ask, "Which white, bright white or cream white?"

For more than 2 years, a regular user of offset had been ordering his 32 × 44—80 lb. paper with grain running the short dimension. Now that's contrary to practice, isn't it? Most standard offset papers are stocked with grain the long dimension. Once the customer failed to specify "short grain." A new clerk didn't connect the customer's requirements with past orders. He followed custom to the letter; the paper was made with grain the long dimension.

If we've seemed to paint a somber-hued picture of the operation of writing orders, we don't mean to. Praise is due the seasoned paper buyer for his painstaking care. We're trying to drive home only the point that the failure to make clear the most inconsequential detail could very well result in costly and annoying situations *at time of delivery, when the paper is being "finished" or bound,* or even *when the completed job has been delivered to the customer.*

It's well to erect safeguards to any future annoyance. That's why the specification list of your paper order form so thoroughly itemizes every last detail of possible importance.

You're oh-so-right when you say this is all old stuff. Nevertheless the whole process of efficient order writing is well worth reviewing detail-by-detail.

Be specific.

If these practices are followed when making inquiries for paper, many an order can be saved and extra profit earned. Why? Because, at the very outset, all the essentials of a good order can be developed from the good inquiry.

True, there are many details of an inquiry that are either *all right* or *all wrong.* These details can be absolutely correct right from the start. It's the little, almost inconsequential items, though, that cause the big troubles later. Items like packing, handling, and shipping. They bear study during the inquiry stage.

Start today to investigate every means of turning your inquiries into extra profit-making sales.

ITEMS TO CHECK WHEN ORDERING PAPER IN SHEETS

Here is a point-by-point check list to help you in writing orders of special nature.

Quantity

Don't write so many cases, so many cartons, so many skids. Specify number of sheets with number of pounds in parentheses, like this—175,000 sheets (62,300 lb.).

Size and Weight

Specify dimensions and weight per 1000 sheets. To pre-

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THE VANDERBILT LABORATORIES

Norwalk, Conn.

★

For Testing and Developing
Methods of Improving
Paper Products

★

R. T. VANDERBILT CO., INC.

230 Park Avenue, New York City

Paper Inquiry and Order Form

This is a check list; you may care to adopt it for your guidance

Salesman

Customer *Date*

Address *Purchasing Agent*

Ship to

Address

Quantity *Sheets* *Pounds*

Size and weight *Basic size & weight*

Color *Grade*

Finish *Design* *Bulk* *Caliper* *Pages to inch*

Watermark

Trimming ☐ 4 sides ☐ 1 side & 1 end ☐ untrimmed
Grain ☐ long ☐ short ☐ optional

Design or pattern direction
☐ long ☐ short ☐ optional
☐ plain edge ☐ deckle edge

Packing ☐ sealed packages ☐ unsealed
☐ standard cartons ☐ junior cartons
☐ single-tier skids ☐ double-tier skids
☐ cases ☐ bundles

Desirable skid specifications ☐ standard
skid runners ☐ short way ☐ long way
distance between runners inches
clearance skid to floor inches
skid height inches maximum inches minimum
skid weight pounds maximum pounds minimum
skid wrapping ☐ double wrappers ☐ single wrappers
☐ mark skid number and contents on runners

Production and finishing
☐ letterpress ☐ gravure ☐ photogelatine
☐ one color ☐ two color offset ☐ multicolor offset
☐ process ☐ heat set inks ☐ high gloss inks
☐ one color offset ☐ metallic inks ☐ embossing
☐ pen and ink ☐ lacquering ☐ virkotyping
☐ varnishing ☐ acetate laminating ☐ dull ☐ glossy
☐ liquid laminating ☐ engraving

Shipping
☐ Railroad siding on R.R. ☐ No railroad siding
☐ Plant has receiving platform ☐ No platform
☐ Can accommodate trailer-trucks ☐ Cannot accommodate trailer-trucks
☐ Maximum elevator load ☐ Maximum elevator skid dimensions

Delivery date wanted
Most satisfactory delivery hour
☐ early a.m. ☐ late a.m. ☐ early p.m. ☐ late p.m.
☐ receiving closed 12–1 p.m.

Plant humidity requirements *Special markings*

vent misunderstanding show ream weight in parentheses, like this—44 × 64—356M (25 × 38—60).

Grade

Specify by *Brand Name;* not by number or letter.

Color

Identify color in correct mill terminology. Don't write "white," when you know the paper is made in cream white and blue white tones. Don't write "blue," when you know there are two blues in the line.

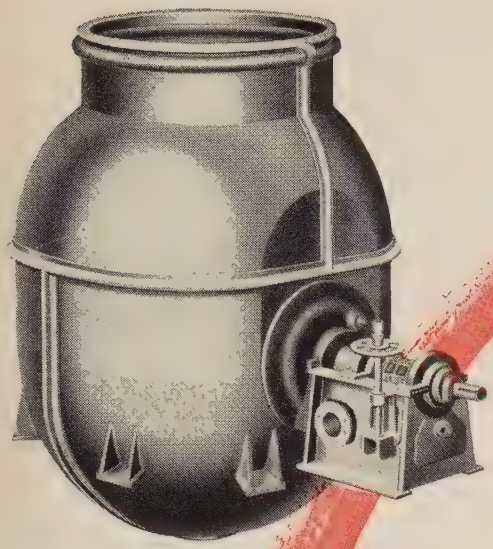
Finish

Identify by name when there is any possibility of misunderstanding. For instance—Laurel finish is a handmadelike finish in one grade of offset. Write Laurel finish, to be sure.

Morden-ize

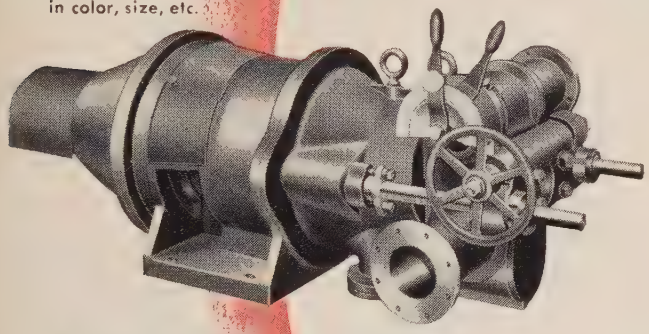
YOUR STOCK PREPARATION

WITH Morden { SLUSH-MAKERS / STOCK-MAKERS / STUFF-MAKERS



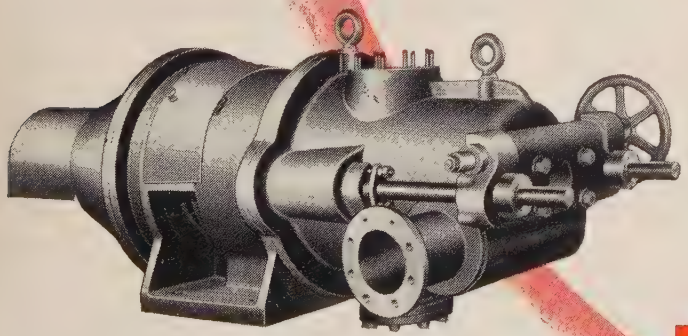
MORDEN "SLUSH-MAKER" FOR PULPING

The "Slush-Maker's" side-mounted rotor quickly and efficiently slushes a full charge of pulp, broke or waste paper, either batch or continuous. The rotor's combination pumping, shredding and brushing blades continually direct the charge at right angles against the attritioning ring, where a controlled bar-to-bar brushing completely clears all flakes and bundles, even high wet strength, without damage to the fibers. The "Slush-Maker's" positive-flow circulation quickly and thoroughly mixes and also brushes in color, size, etc.



MORDEN "STOCK-MAKER" FOR BEATING

The "Stock-Maker" with its 360° bed plate gives the maximum of brushing, fibrillating, beating or hydrating treatment with the minimum of cutting. The "Stock-Maker" operates on a continuous-flow basis from chest to chest or chest to stuff box. The reverse-flow, sealed pressure treatment of one "Stock-Maker" will duplicate or improve upon the stock treatment of two or three conventional beaters and yet requires only one third the space of one beater.



MORDEN "STUFF-MAKER" FOR JORDANING

The "Stuff-Maker" utilizes the "Stock-Maker's" well proven construction features but provides a "jordan-type" flow, for shortening or cutting the stuff when required.

Experience with nearly 700 Morden Machines in 175 mills on all types of pulp and grades of paper proves that:

These three Morden Machines are especially designed, each to excel in one of the three phases of stock preparation—pulping, beating or jordaning.

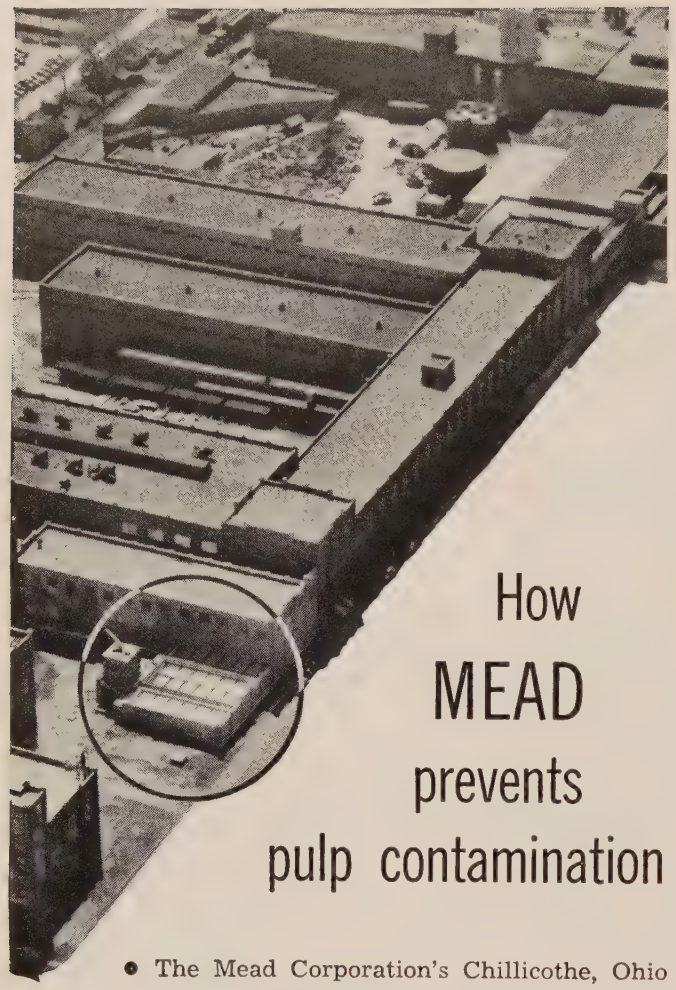
Each of these Morden Machines is engineered for the utmost in efficiency, simplicity, versatility and economy of operation.

These Morden Machines are designed to fit readily into all types of stock preparation systems and can be used together or in combination with existing equipment to give efficiently the various treatments required for developing the most in each furnish.

Let us know of your interest, and we will gladly provide detailed information on how to advantageously Morden-ize your stock preparation system.

MORDEN
STOCK PREPARATION EQUIPMENT
MACHINES COMPANY

Corbett Building, Portland, Oregon.



How MEAD prevents pulp contamination

• The Mead Corporation's Chillicothe, Ohio Division makes pulp for a wide range of high quality papers.

In proposed three-stage chlorine, caustic, and hypochlorite bleaching, untreated well water would have caused trouble. When its 266 ppm of calcium hardness came in contact with caustic soda, heavy scale would form on bleach tanks. Such scale breaks loose in discolored chunks, plugging washer wires, contaminating pulp.

Two Permutit Precipitators installed in 1947 prevented these problems . . . remove hardness. They also eliminate the waste of weekly descaling of turbine condensers. Efficient Precipitator reaction reduces iron—prevents spotting of pulps and papers—without the need of filters!

Permutit know-how and equipment can help you to produce finer pulps and papers at lower costs—regardless of raw water conditions. For details, please write to THE PERMUTIT COMPANY, Dept. TAP-10, 330 West 42nd Street, New York 36, N. Y., or Permutit Company of Canada, Ltd., 6975 Jeanne Mance St., Montreal.

Registered Trade Mark

PERMUTIT

WATER CONDITIONING HEADQUARTERS FOR OVER 40 YEARS

No two handmade finishes are identical in texture or character.

When the finish is a design, identify it by name or number. When the paper is safety check, indicate *direction of the chain line.* When the paper is text or text-cover, indicate dimension of grain, chain line, and deckle.

When the paper will be lithographed—yes, even when you're sure that the paper is especially suited to most severe production requirements—specify "for duotone offset and silver." Give a Dennison wax reading when there is a preference.

Don't leave anything to conjecture.

When the paper will be processed via photogravure (sheet-fed) or by photogelatine, be extra sure to say so. The surface of the paper must be made harder.

When you know the paper will be run on sheet-fed rotary letterpress equipment, say so. For wet color printing the surface must be hardened.

When the paper will be varnished, lacquered, laminated, embossed, or "finished" after printing in any other manner, be sure to say so. Many standard papers are not suited to varnishing or lacquering. Specially treated, they're perfectly satisfactory. You have only to spell out your exact requirements. Failure to mention additional properties necessary for effective production will lead directly to certain grief.

When you know the paper will be printed with high-gloss inks, heat-set inks, or other special kinds of inks, be sure the paper manufacturer knows the facts. You'll take further precautions in cases like these when you identify the inkmaker and the ink by number.

Grain

Specify exact direction of grain—long or short dimension. When grain direction is not important, specify "grain optional."

Trimming

Specify squared-four-sides when you mean just that. While many grades of paper are standard trimmed-four-sides, don't take it for granted. You may need English finish book paper trimmed-four-sides. Not to say so will most certainly cause trouble later. The paper will be automatically delivered to you machine trimmed because that's standard practice in the trade.

When you know that paper trimmed one side and one end is perfectly satisfactory for your production purposes, make that point crystal clear.

When you need text paper with plain edge, be sure to say so. Fail to mention it and you'll receive your paper with a lovely feathery deckle edge. Ornamental, no doubt, but not useful.

Packing

Identify exact packing required—*in cartons*, standard size, or junior size (contains 10 reams of cut sizes $8^1/_2 \times 11$ or $8^1/_2 \times 14$); *in cases, on skids.*

Whatever the packing, be sure to specify whether the paper is to be sealed in packages or unsealed (marked).

Be sure to underscore weight limitations, if any. When so many printing and lithographing shops are situated in old loft buildings, weight and size limitations are bound to arise. Skid-loads of anything less than the standard 3000-lb. weight should be signaled. When you know that elevator capacity, width of doors, make it necessary to pack paper on single-tier skids, say so in cap letters.

When you know skids must be double-tiered for practical reasons, say so. When you know you want skids double-wrapped to seal-in mill-made moisture content, make the point clear.

When relative humidity of the plant is known be sure to specify R.H. maximum and minimum for the time of year.

TROUBLESOME FOAM PROBLEMS?

BEATER SWELLING

STOCK PUMP BINDING

FOAM AT THE SCREEN

FOAM ON THE HEADBOX

FOAM SPOTS IN THE PAPER

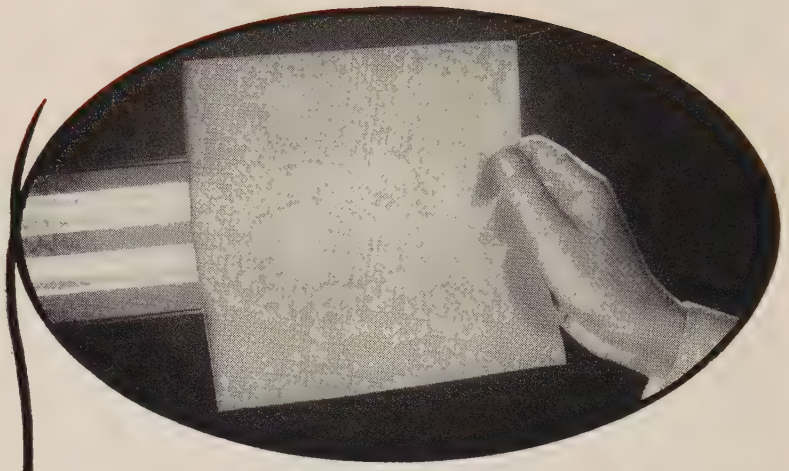
FIBER FLOCCULATION

FOAM IN THE WIRE PIT

FOAM AT THE MIXING BOX

FOAM AT THE SEAL BOX

FOAM AT THE SAVE-ALL



Get help from new low-foaming MERSIZE

Excessive foaming can raise troublesome, costly problems throughout the papermaking process. And, of these problems, one of the most serious is *foam spots in the finished paper.*

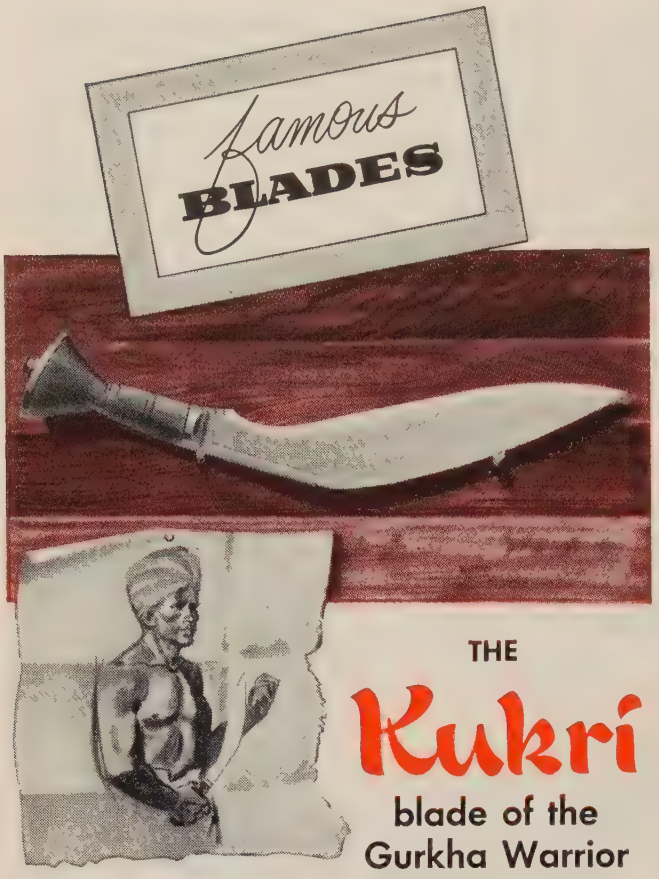
To reduce chances of foam (free) spots—and to minimize the other difficulties caused by sizes with a high foam index—more and more mills are switching to low-foaming Mersize. And, along with its new advantage in overcoming foam troubles, Mersize continues to give you high sizing efficiency and low sizing cost.

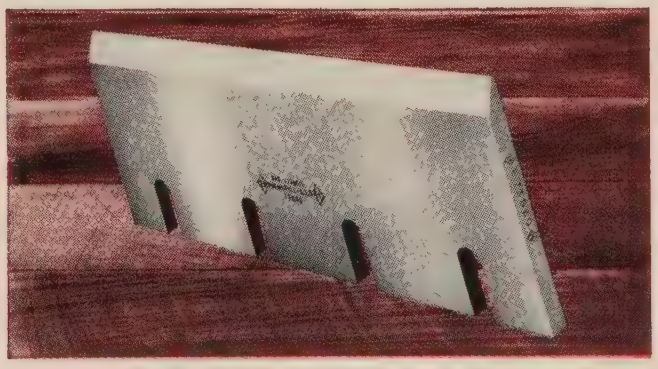
To prove to yourself how the drastically lowered foam index of Mersize can improve *your* operation, use a tank car under your own production conditions. MONSANTO CHEMICAL COMPANY, Merrimac Division, Boston 49, Mass.

Mersize: Reg. U. S. Pat. Off.

MONSANTO®

SERVING INDUSTRY . . . WHICH SERVES MANKIND





Heppenstall CHIPPER KNIVES

famous for their service to modern industry

Heppenstall Chipper Knives are known throughout the pulp producing industry for their dependability. These are the blades that provide:

- *More cuts between grinds*
- *Less sawdust waste*
- *Lower overall blade cost*
- *Less oversize chips*

Make Heppenstall Chipper knives your standard specification.

Heppenstall

the most dependable name in Chipper Knives

PITTSBURGH 1, PENNSYLVANIA

Sales offices and distributors in principal cities

Delivery

Be specific about delivery date. Specify most desirable delivery time—early morning, mid-morning, early afternoon, late afternoon. When you know the receiving department is closed during the usual 12 to 1 lunch hour, say so.

Shipping

When your plant has a railroad siding, say so. Identify the railroad.

When your plant has a receiving platform, be sure to indicate whether or not truck-trailers can be accommodated.

When your plant has no receiving platform, be sure to say skid loads must be delivered by winch truck.

When you know the paper is being shipped into a warehouse, be sure to identify it. If it is situated on a railroad siding, say so.

Special Requirements

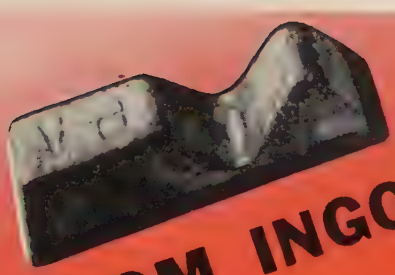
When adherence to certain scientific manufacturing requirements is important, itemize your order property-by-property, characteristic-by-characteristic. When strength is the factor, emphasize by measured reading the folding strength, the tearing strength, the bursting strength, whichever property is essential to the job. When you know the opacity reading of a paper that is considered acceptable, be sure to make it clearly a part of the order. When you know the bulk, the caliper thickness desired, write it out. When you know how many pages there are to the inch, write it out so your supplier will be fully informed.

The more complete the specifications you write, the fewer chances of mistakes and the awful consequences.

SOME PAPER-BUYING TIPS THAT BEAR FURTHER INVESTIGATION

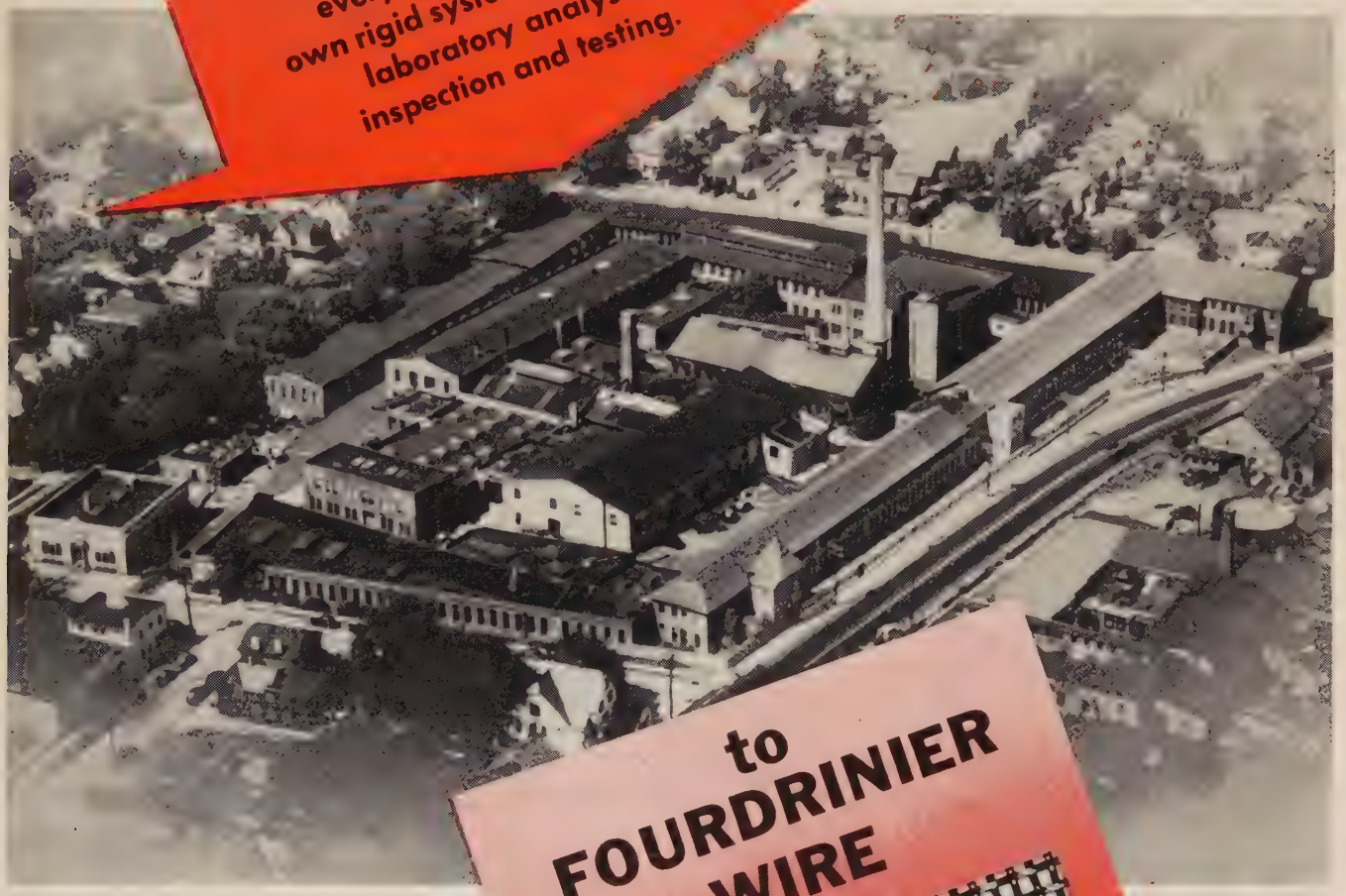
1. Are you acquainted with *all* of your "within a grade assortment buying privileges?"

	Grade	*Quantities*	*Assortments permitted*
(a)	Bond, ledger, writing, mimeo, duplicator, thin papers, index—sealed in cartons	4 ctn.—16 ctn.	No item less than package
		5000—36,000 lb.	No item less than carton
(b)	Printing bristols—unsealed in cartons	4 ctn.—36,000 lb.	No item less than carton
	Printing bristols—sealed in cartons	4 ctn.—16 ctn.	No item less than package
		5000—36,000 lb.	No item less than carton
(c)	Opaque—unsealed in cartons	4 ctn.—16 ctn.	No item less than carton
(d)	Vellum—sealed in cartons	4 ctn.—16 ctn.	No item less than package
(e)	Vellum bristol—sealed in cartons	4 ctn.—16 ctn.	No item less than package
		5000—36,000 lb.	No item less than carton
(f)	Postcard—unsealed in cartons	4 ctn.—36,000 lb.	No item less than carton
(g)	Coated postcard—sealed in cartons	4 ctn.—16 ctn.	No item less than package
	Coated postcard—unsealed in cartons	4 ctn.—16 ctn.	No item less than carton
(h)	Tag—unsealed in bundles	4 bdl.—36,000 lb.	No item less than bundle
(i)	Blanks—sealed in cartons	4 ctn.—16 ctn.	No item less than package
	Blanks—unsealed in cartons	4 ctn.—16 ctn.	No item less than carton
(j)	Blotting—unsealed in cartons	4 ctn.—16 ctn.	No item less than carton
(k)	Gummed—sealed in cartons	4 ctn.—16 ctn.	No item less than carton
(l)	Text and text cover—sealed in cartons	4 ctn.—16 ctn.	No item less than package
	Text and text cover—unsealed in cartons	4 ctn.—16 ctn.	No item less than carton



FROM INGOT

. . . to your finished fourdrinier wire, every step is under our own rigid system of controls—laboratory analysis, inspection and testing.



to FOURDRINIER WIRE

....in a completely integrated plant

EASTWOOD-NEALLEY CORP.

Belleville · New Jersey

Grade	Quantities	Assortments permitted
(m) Cover—sealed in cartons	500—2000 lb.	No item less than package
	5000—36,000 lb.	No item less than carton
(n) Fancy cover—sealed in cartons	4 ctn.—16 ctn.	No item less than package
(o) Book paper—unsealed in cases	4 cases	No item less than case
Book paper—unsealed in cartons	4 ctn.—16 ctn.	No item less than carton
(p) Offset—unsealed in cases	4 cases	No item less than case
Offset—unsealed in cartons	4 ctn.—16 ctn.	No item less than carton

(q) You may assort regular finish sulphite bond paper with ripple, linen, and any other finishes standard within the grade
(r) You may assort text and matching cover papers
(s) You may assort white and colored blanks, carsign and display board
(t) You may assort plain and coated blotting
(u) You may assort white and colored, coated and plated gummed
(v) You may assort regular and opaque rag bonds
(w) You may assort regular and fancy finish offset papers
(x) You may assort lightweight and heavyweight in wedding vellum and bristol

2. Are you acquainted with minimum-quantity privileges in a special size without paying penalty?

Grades		Minimum quantity without penalty
Sulphite bond, mimeo and duplicator in cut sizes	..	1000 lb.
Sulphite bond, ledger, writing, mimeo, duplicator, index	Sheets	2000 lb.
	Rolls	500 lb.
Rag bonds, ledger, writing, thin papers, vellum	Some	1000 lb.
	Some	2000 lb.
Rag index	..	2000 lb.
Offset	Some	500 lb.
	Some	2000 lb.
	Some	5000 lb.
Coated book	Some	2000 lb.
	Some	3000 lb.
	Some	5000 lb.
Text	..	2000 lb.
Cover	..	2000 lb.
Coated bristol	Some	2000 lb.
	Some	3000 lb.
	Some	5000 lb.
Bristol	Some	1000 lb.
	Some	2000 lb.
	Some	5000 lb.
Sulphite wedding bristol	Some	2500 lb.
	Some	5000 lb.
Rag wedding bristol	..	2000 lb.
Opaque vellum	Some	2000 lb.
	Some	5000 lb.

3. Do you know some mills extend other buying privileges when your size is considered "standard" by the trade? For instance: *Beckett Paper Co. will manufacture 500 lb. of Beckett Offset in a "standard" size not necessarily one of their stock sizes; S. D. Warren Co. will manufacture 2000 lb. of any grade in a size considered by the trade "standard" for the grade.*

PACKING SCHEDULES

Bond Paper

Sheets per carton, ream weight—17 × 22

Size	13	16	20	24
22 × 34	2500	2000	1500	1500
24 × 38	2000	1500	1500	1000
28 × 34	2000	1500	1500	1000

For single sizes double above quantities.

Ledger Paper

Sheets per carton, ream weight—17 × 22

Size	24	28	32	36
22 × 34	1500	1000	1000	1000
24 × 38	1000	1000	750	750
28 × 34	1000	1000	750	750

For single sizes double above quantities.

Opaque Paper

Sheets per carton, ream weight 17 × 22

Size	13	16	20	24	28
17 × 22	5000	4000	3000	3000	2000
22 × 34	2500	2000	1500	1500	1000
28 × 34	2000	1500	1500	1000	1000
25 × 38	2000	1500	1500	1000	1000
35 × 45	1250	1000	750	750	500
38 × 50	1000	750	750	500	500

Book Paper

Cartons.....Weigh approximately 130 lb.
Cases.....Weigh approximately 600 lb.
Skids.....Minimum weight 3000 lb.

Cover Paper

Sheets per carton, ream weight—20 × 26

Size	50	65	80	90	100	130
20 × 26	1500	1000	750	800	700	500
23 × 35	1000	750	500	500	500	300
26 × 40	750	500	500	400	300	300

Index Bristol

Sheets per carton, ream weight—25½ × 30½

Size	90	110	140	170
20½ × 24¾	1200	1000	800	600
22½ × 28½	1000	800	600	500
22½ × 35	800	600	500	400
25½ × 30½	800	600	500	400

Printing Bristol

Sheets per carton, ream weight—22½ × 28½

Size	60	80	90	100	115	120	140	160
22½ × 28½	1000	700	700	700	600	600	500	400
22½ × 35	..	..	..	600	..	500	400	..
26 × 40	..	..	..	400	..	400	..	..

Tag

Sheets per carton, ream weight—24 × 36—100

Size	100	125	150	175	200	250
22½ × 28½	1000	750	600	600	500	400
24 × 36	750	600	500	400	400	300

HOW TO ORDER PAPER IN ROLLS

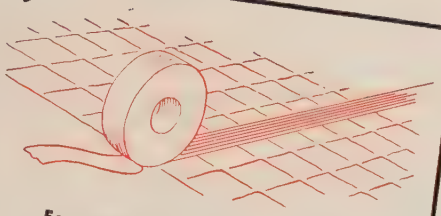
If you are new at buying paper in rolls, however seasoned you are in paper know-how—*prepare for some hard knocks.*

Why? Because you'll be talking in a brand new idiom. Not lingo altogether strange to you, granted, but different enough to harass you; yes, and embarrass you, until you've established a definite specification pattern.

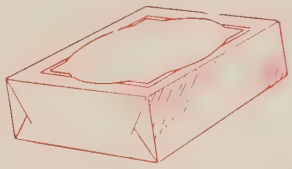
First, you'll want to know how the purchase of paper in rolls is so essentially different from the routine of purchasing paper in sheets.

Production processes to which roll paper is exposed are as obviously different from sheet-fed operations as day is from

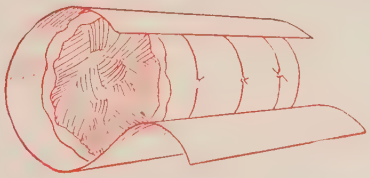
For rubber-backing papers, interleaver sheets, and containers used in packaging tacky products, "Quilon" makes possible easy stripping.



For pressure-sensitive tapes and label backings, "Quilon" checks blocking under prolonged storage.



For bakery trays and sheet pan liners, "Quilon" greatly reduces sticking of baked goods.



For meat and frozen-food wrappers and trays, "Quilon" eliminates paper adhesion to food, permits easy removal from package.

For better RELEASE treat paper with Du Pont "QUILON"®

stearato chromic chloride

You get a superior release treatment—at low cost—when you use Du Pont "Quilon" stearato chromic chloride. "Quilon" is non-migratory—anchors tightly to the fibers of paper, giving it release properties that last. Yet the cost is low because the amount of "Quilon" needed is so small.

"Quilon" can give your paper new sales features through its other outstanding properties, too. Use it to get excellent size and water repellency. "Quilon" doesn't give paper a waxy feel . . . doesn't adversely affect any dry properties of paper. "Quilon" also minimizes water sensitivity of many soluble or emulsion-type coatings and adhesives.

Easy to apply by spray, transfer rolls or immersion, "Quilon" can be used for treatment at the size press, at calender stack water boxes, or with converting equipment.

Send for technical bulletin *giving more facts and figures—uses and methods of application—on versatile Du Pont "Quilon." Mail this coupon now.*

"Quilon" is a registered trade mark of E. I. du Pont de Nemours & Co. (Inc.)

E. I. du Pont de Nemours & Co. (Inc.)
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BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

night. The buyer, or specifier, of paper for sheet-fed presses is thoroughly acquainted with trade customs, practices, and nomenclature. A price list tells a complete story of grades, sizes, weights, finishes, packing, handling.

The mechanical operations of sheet-fed letterpress, lithography, and gravure are familiar, and papers to be used most satisfactorily for each process fall into set patterns.

All this information is common knowledge. People in graphic arts plants are weaned on it.

But, because there are no established standards for paper in rolls; because every order for paper in rolls is tailor-made; because operators of web-rotary presses make most profitable use of their machinery's facilities, width, and accessories, no simple rules can be laid down.

A veteran manufacturer of web-rotary presses, talking about paper requirements for web-rotary presses, said, "Paper must be fitted to the job. The selection of the paper should be determined by the speed of the press, by the number of operations—after printing—the paper must endure; the kinds of ink, the number of colors to be applied one over the other, the area of coverage, whether you're printing on one or two sides of the sheet, and the quality of the results desired."

The *job-determines-the-paper* theory, therefore, is an even more important consideration when you know the paper will be processed on web rotaries.

Remember this—the paper runs off a reel and delivers in sheets or in rolls for slitting later. Running at extremely high speed, the paper's strength and printing qualities are tried severely. Particularly on web-rotary presses that print on both sides of the sheet in one operation.

Remember, too, that it's not unusual for paper in process on some web-rotary presses to pass through several operations *after* printing. For instance, in addition to usual printing, lithography or gravure—up to four colors—paper is punched for all sorts of business systems, numbered, perforated—lengthwise and crosswise, rewound, slitted, and folded. That kind of single-flow processing represents an unsparing ordeal for any paper.

The valuable advice of another highly experienced press manufacturer is also worth driving home. "It's a fact," he said, "rolls that might be entirely satisfactory for letterpress printing will not get by on precision lithographic presses. Be sure the paper manufacturer knows what process of reproduction will be used and on what particular press the paper will be run. While all rolls should be wound accurately and trimmed accurately, it's especially important that rolls for high-speed offset presses be handled with extra care and precision."

Those are your warning signals.

Here, though, is a bright note. Now, papers used on web-rotary presses are chiefly limited to a few classifications: *book papers—coated, super, English finish, machine finish, antique; coated-one-side label; bond, writing, ledger,* and *thin papers.* Of course, there's no reason in the world why you can't print bristols, index, tags, and boards that are pliable enough to go around the feed roller and the turning bars. And there is some call for these grades. Several specialists in the production of merchandise tags are currently printing 0.010 coated-bristol very satisfactorily. Still others are regularly running three-ply tough check, 150-lb. tag stock and 91-lb. index.

It's only a matter of time before more and more heavier weight papers and a greater variety of papers are generally printed on web rotaries.

For the present, and because scarcely more than a handful of printers and lithographers are *seasoned* buyers of paper in rolls, we are treating the subject in a-b-c fashion.

It's certain, however complete a list of *do's* and *don'ts* we compile, you are still going to encounter circumstances that aren't "in the book." Be prepared, then, to enroll early in the school of hard knocks.

Drawing on the personal experiences of paper men, lithographers, and printers, you can erect a fairly solid shield to at least help soften some of the blows.

Suggestions on Ordering

1. *It's important to order rolls made to maximum diameter.* Why? Because, press operators say, the fewer roll changes in a run, the fewer the press adjustments, the more profitable the operation.

2. *It's important to limit the number of splices to the roll.* Why? Because the greater the number of splices encountered, the greater the number of press adjustments, the more press time lost, the greater the loss of paper yardage. More important, there is a possibility of running into a splice that isn't flagged and suffering the consequences of broken blankets, smashed plates; even damaged presses.

3. *It's important to "flag" all splices.* Why? Because, as just pointed out, unflagged splices raise all sorts of havoc on presses. Broken blankets are a certainty on offset presses; battered plates, and worse, lost machine time. An operator tells how one of his major producing machines was out of operation an entire week because a splice on a roll was not flagged. The over-all loss to the operator mounted into thousands of dollars.

4. *It's important to specify the maximum basis weight required.* Why? Because the operator buys yardage, not pounds of paper. When ordering 17 × 22—20-lb. bond paper without stipulating "not heavier than," buyers may receive 21, 22, or even 23-lb. paper. Consequently, yardage is cut down, yielding fewer forms, letterheads, envelopes than figured.

5. *It's important to allow for at least 5% spoilage when estimating.* Why? Because the weight of the roll always includes the outside wrapper and the core; also because in unwrapping the roll, the paper is invariably damaged in some degree. In transit, rolls might be dropped on their edge or otherwise knicked. Almost always—depending on the weight of paper—the last 5 to 10 lb. of paper nearest the core are worthless since the paper is curled beyond value.

6. *It does no harm to specify "free from slitter dust."* Why? Because slitter dust causes all sorts of trouble when the job being produced shows large solid areas of black or color. The dust piles up on the blanket of the offset presses and clogs the plates on the letterpress and gravure presses. Result: spoilage; lost time for wash-ups.

Note: Most mills wind very satisfactory rolls. They've overcome the "slitter dust" trouble by installing special vacuum cleaning units on slitting machines.

7. *It's important to stipulate "tight wound rolls."* Why? Because soft, unevenly wound rolls are useless. They are likely to telescope in transit. When rolls are slightly uneven—high on one side—the paper can be run, with care; but time is lost.

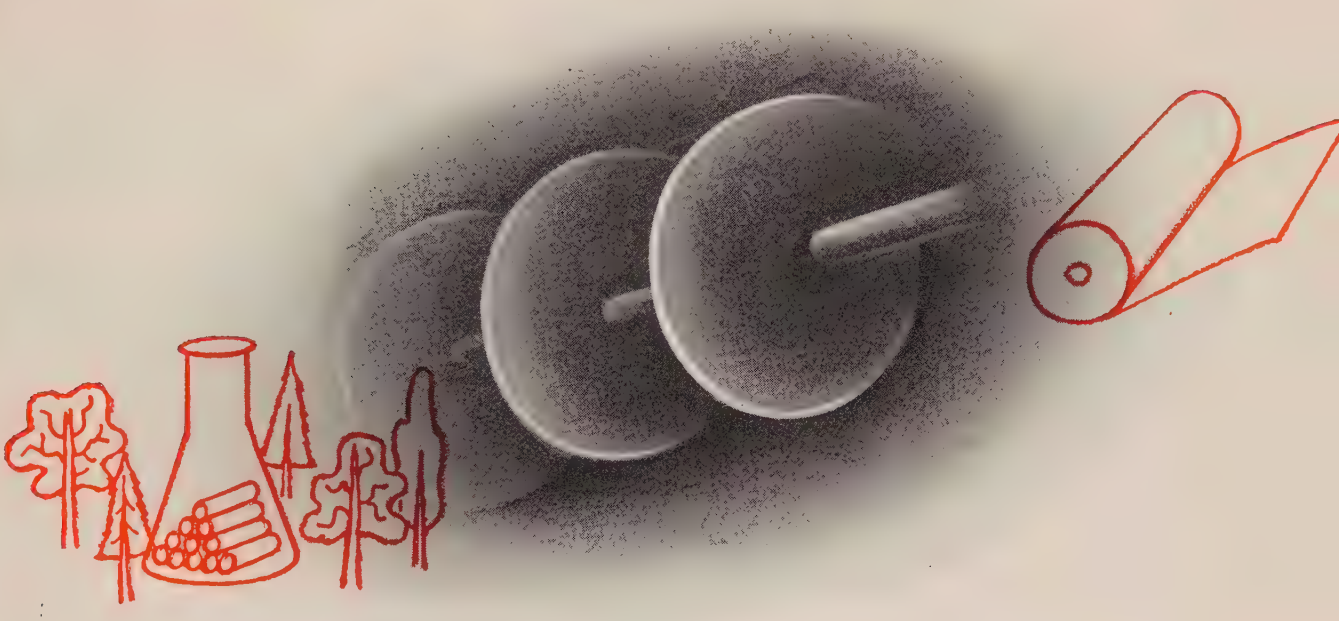
8. *It's important to provide the proper "core" information.* Why? Because there are no standard-size cores. Weights of paper and board dictate diameter and style. Three-inch cores are in most general use. But some operators want non-returnable cores; others want returnable cores. Some want slotted cores. Others don't.

9. *It's important to stipulate "rewound" when rolls are narrow width.* Why? Because narrow gage equipment is high precision equipment. Slitting must be exact. Winding must be hard and firm.

10. *It's important to estimate carefully. Don't take anything for granted.* Why? Because, allowances—differentials between standard-packed sheets and rolls—are not standard with all paper manufacturers. Until buyers establish an expert working knowledge of mill practices, it's wise to investigate each inquiry. For instance, some mills deduct $1.45 a hundredweight from case-packed prices to arrive at cost of roll merchandise. Other mills deduct $1.75. Some mills

meeting the needs of the present
with an eye toward the future

PANDIA
CONTINUOUS PULPING EQUIPMENT



Today's heavy demands for the pulp requirements of prominent mills in this country and elsewhere making products ranging from board to bleach grades are being met with continuous digesters—designed, engineered and manufactured by Pandia, Inc., leaders and trail blazers in the field of chemical pulp processing.

These mills are sufficiently foresighted to install equipment that will be equal to the task of even heavier demands for high quality pulp for the complete range of paper products in tomorrow's markets here and abroad.

One of Pandia's engineers will be glad to consult with you concerning plans for your new plant or for modernizing your present operations.

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make no additional charge for winding rolls larger than 12 in. Other mills charge an additional 25 cents a hundredweight for rolls between 17 and 12 in. in width. Still another charge is added for rolls narrower than 12 in. Weight-per-roll also determines pricing. With some mills, rolls of 250 lb. carry a higher price than 500-lb. rolls. It is, therefore, best to check when ordering.

Some Tips When Writing Orders for Paper in Rolls

Indicate clearly

- ☐ speed of press
- ☐ exact roll width
- ☐ minimum and maximum diameter
- ☐ machine roll
- ☐ rewound roll
- ☐ wire side out
- ☐ felt side out
- ☐ for letterpress
- ☐ for lithography
- ☐ for gravure
- ☐ one color
- ☐ two colors
- ☐ three colors
- ☐ four colors
- ☐ one side of sheet
- ☐ both sides of sheet
- ☐ directional arrows on wrappers of large rolls

Core specifications

- ☐ inside diameter
- ☐ fiber ☐ metal
- ☐ returnable
- ☐ nonreturnable
- ☐ slotted
- ☐ width of slots
- ☐ not slotted
- ☐ slots in juxtaposition

Be sure to insist upon high-quality hard rolls

- ☐ tight wound
- ☐ even wound
- ☐ free from slitter dust
- ☐ load on side
- ☐ on end
- ☐ on skids
- ☐ minimum of splices—indicate how many splices-per-roll are acceptable
- ☐ flag splices

Be sure to indicate weight of paper as maximum—not to do so cheats you of yardage.
Caution—remember weight of roll includes outside wrapper and nonreturnable core.
Remember, you are billed for gross weight of roll—paper, wrapping, and nonreturnable core. Weight of returnable core is not charged.
When estimating, be sure to allow for spoilage. Most operators say 5% covers loss of paper weight.
Be sure to instruct supplier to number and show weight of each roll on outside wrapper and on shipping and billing papers.
Be sure to indicate when printing is to be produced with heat-set or other special inks. Extreme care is given the "pick" factor, and splices are properly treated for processing.

Arithmetic Help

Here is an approved method of figuring the approximate weight of paper in rolls:

Example: To determine the weight of a roll of bond paper that is 30 in. in diameter and 12 in. wide: square the diameter, $30 \times 30 = 900$; multiply by the width, $900 \times 12 = 10{,}800$; multiply by the factor 0.027, $10{,}800 \times 0.027 = 291.6$.

Answer: 291.6 lb.

These are the factors to use to help you determine the approximate weight of a roll for papers purchased in rolls: antique finish, 0.018; machine finish, English finish, offset, bond, ledger, writing, manifold, onion skin, 0.027; super, 0.030; coated two sides, 0.034; coated one side, 0.030. These factors—average among paper manufacturers—apply for all weights.

For any given diameter, lighter weight papers will bulk less. More of it, therefore, will be wound on a roll.

Approximate Weight of Rolls per Inch of Width

Multiply figures below by roll width to get weight of roll

Grade	*28 in. diam.*	*30 in. diam.*	*32 in. diam.*	*34 in. diam.*	*36 in. diam.*	*38 in. diam.*	*40 in. diam.*
Coated two sides	26.7	30.6	34.8	39.3	44.0	49.1	54.4
Coated one side	23.5	27.0	30.7	34.7	38.9	43.3	48.0
Super	23.5	27.0	30.7	34.7	38.9	43.3	48.0
English finish	21.2	24.3	27.6	31.2	35.0	39.0	43.2
Antique	14.1	16.2	18.4	20.8	23.3	26.0	28.8
Offset	17.1	19.7	22.5	25.4	28.4	31.6	35.1

DON'T BUY PAPER BY "NUMBERS"— NO TWO PAPERS ARE IDENTICAL

There are few winners in the numbers games—policy slip or paper classification. Because it's obvious that no two papers in any given classification can possibly be identical on every count, or for that matter on most counts. Paper manufacturing techniques, craftsmanship, qualities of materials and methods, even papermaking machines can't possibly be identical in all parts of the country at all times.

Papers worth their salt have definite *points of difference.* Smart paper merchandisers trade on them and seasoned paper buyers capitalize on them. Points of difference are special brightness factors, special strength factors, special bulk factors, proved performance factors, and so on.

Isn't it just as good business for paper marketers and paper users to exploit *points of difference* as it is for makers of all sorts of other products to cash in on their superiorities and exclusive features?

See how Buick sells the benefits of "Dynaflow Drive" to the motoring public.

Hundreds of other advertisers spend millions of dollars to exploit the points of difference of their products.

To repeat for a minute, almost every paper that has won the acceptance of the paper-using and paper-buying trade, has one or more superiority features than can be made to work to advantage. That's why it pays to know the *points of difference* of the papers you regularly sell and use.

That's why it will pay you to study each of these seven case histories for the object lesson each drives home.

Case No. 1. An inquiry for 10,000 lb. of 25 × 38—70-lb. offset paper underscored "equivalent to such-and-such offset paper." Quoting, paper merchants recommended grades they carried in the so-called "No. 2" classification. Prices for the most part were identical. But . . . the paper selected subsequently proved unsatisfactory for the purpose.

Why? Because the printed job was a broadside that folded down to 6 × 9 from a 19 × 24 spread. By nature hard, the paper was unusually stiff. Never a question, though, about its press-worthiness. The paper breezed through the presses. Colors sparkled. Halftones shone on the lovely surface. The press sheet was a delight for all to behold. But, oh what happened in the bindery!

All sorts of folding grief, and cracking. As a result, a rerun was necessary. The second time around, greater consideration was given the strength factor. Best possible folding qualities were demanded. Another mill's paper, more supple and better suited to withstand the severe folding requirements, not only lithographed satisfactorily, but also drew a round of applause from the binder.

Was the second offset paper among those originally recommended by the paper salesman for the job?

It was. But, ironically, it wasn't considered "stiff enough."

Special Note: It pays to know the especial advantages of each offset paper. No two grades are identical. They differ widely in whiteness, in brightness, in opacity, in bulk, in folding qualities, in smoothness-of-surface, just to list a few obvious check points.

Case No. 2. An inquiry for 36,000 lb. of 25 × 38—80-lb. coated book paper called for "No. 2 coated equivalent to thus-and-so brand." Well-known grade names—recognized trade-wide as standard mill brand papers—were submitted by most of the merchants answering the inquiry. Prices were almost identical. However, when the buyer narrowed down the recommendations to four papers, two private brands—"No. 2 Enamel Book" they were labeled—were in the running for the order on the basis of low price.

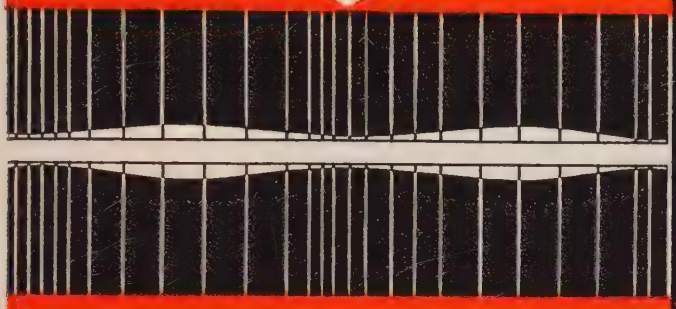
Now, the written inquiry mentioned nothing at all about the end use of the paper. Never a word that the booklet the paper was intended for was a mass of beautiful black and white halftone reproductions. Nor that the original photographs had cost a young fortune to take and retouch. Nor even a word about the staggering sum spent for photoengravings.

for

UNIFORM PENETRATION

of adhesive in corrugated paperboard

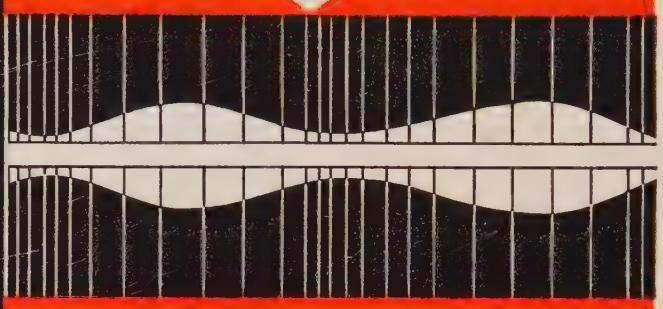
THIS



Controlled Penetration with KELSIZE

Here — you can see how penetration of adhesive is controlled, regardless of variation in paperboard porosity, through the use of a fraction of a per cent of Kelsize added to the adhesive.

NOT THIS



Uncontrolled Penetration

Note that where penetration of adhesive is uncontrolled, the variation of penetration is in proportion to the variation in porosity of the paperboard.

use

KELSIZE

KELSIZE gives you these advantages

Less adhesive used . . . less moisture to remove
Adhesive where you want it . . . where it's needed
Reduced warping . . . stiffer board
Higher machine speeds

Our Technical Service Department will gladly give you more detailed information. Write or call our nearest office.

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Price-minded, the paper buyer chose one of the two unidentified brands.

The price differential was substantial enough to be considered thoughtfully. The difference between the unbranded grade and the standard brands was $2.05 a hundredweight.

But the jarring experiences that followed delivery brought on many a sleepless night. Lacking luster, lacking brightness, the paper didn't represent a suitable setting for the photographic jewels in letterpress halftone form.

The printer summoned all the craftmanship at his command to step up the quality of reproduction. The ink manufacturer couldn't have been more cooperative. Nor could the photoengraver whose handiwork cried out for loving care.

But all to no avail. The buyer learned a bitter lesson.

The book has since been reprinted at considerable expense.

Special Note: It pays to be a student of coated book papers. No two grades—regardless of price—are identical. They differ widely in whiteness, in brightness, in opacity, in bulk, in ink receptivity, in uniformity of surface. Some are recommended for folding. Others are not. Cataloging each brand name according to its advantages is just good buying procedure.

Case No. 3. This is a short, but very sad, sad story.

When he ordered 5000 lb. of 20 × 26—80-lb. coated paper, the printer knew what he wanted. Knew the grade he needed; the mill brand he preferred. He'd used the paper before, also its companion book paper.

When this lovely, four-color process cover was completed, everyone was pleased. The cover was a work of art.

But, alas and alack, came time for varnishing . . . and grief heaped high. The surface soaked up varnish almost as blotting absorbs water. You'd never know varnish had been applied.

To save the day and investment, the cover was laminated with an acetate covering. A costly "save," you'll agree.

All because the printer assumed the coated cover paper he purchased was suitable for varnishing. It wasn't. The manufacturer made no such claim.

Special Note: It pays to catalog all the advantages of all the available coated cover papers. They differ widely in whiteness, in brightness, in finish, in bulk, in weight, in folding qualities. Some are suited for lithography. Some are not. Some may be satisfactorily varnished. Others may not. Be sure to know certainly which grade is best suited for your purpose.

Case No. 4. How equivalent can equivalent be?

"Equivalent to XYZ mimeo," the inquiry stated, and identified one of the best-known names among business papers. But the large corporation's buyer accepted a mimeograph paper with basic characteristics different in every respect. The specified grade represented typical mimeo-bond—it was smooth, even-surfaced, firm-textured: the "equivalent" was soft, highly-bulky with uneven surface.

Prices were equivalent all right. Fact is, they were exact to the penny, but there equivalence stopped.

The press operators weren't happy with the change of the papers. The new paper didn't run "as smoothly," they said. Waste piled up. Impressions weren't as "clean and neat" as they had been on the XYZ mimeo.

The buyer, qualifying his purchase, said the paper "feels like more for the money."

By actual scale weight, though, XYZ mimeo was a uniformly generous 17 × 22—20-lb. paper. The "equivalent" paper varied from 19 to 21 lb.

Special Note: It pays to know the advantage of each mimeograph paper. They differ widely in surface, in texture, in ink receptivity, in bulk, in sizing.

Case No. 5. This buyer assumed that all identically priced English finish book papers were equally opaque.

Pressed for quick delivery, the buyer didn't hesitate a minute to order additional paper from a second mill for a book already on the press.

As fate was bound to have it, the new forms the publisher was adding contained a great many big, black halftone illustrations. The English finish paper originally ordered printed the halftones with a surprising minimum of show-through. So little, in fact, that the publisher was perfectly satisfied.

He wasn't as pleased when the new forms were printing.

Ponderously black as the halftones were, type matter on the reverse side of the paper was scarcely readable. Production was halted. The publication date was delayed while new paper was ordered.

Special Note: It pays to know which English finish book papers are characteristically more opaque; which more bulky; which favor the M.F. finish; which the velvety-smooth E.F. surface. It pays, too, to know which, mills can provide extra high finishes without upcharge for supercalendering.

IMPORTANCE OF THE BULK FACTOR

It's axiomatic . . . the job determines the paper. Paper men have for years driven home that counsel. That's why standards were mutually adopted by printers, lithographers, and papermakers.

But it's also axiomatic—as every printer knows—customer budgets as often as not play major roles in determining the paper the job is eventually printed on.

That's where ingenuity counts—ingenuity in the form of applied knowledge of papermaking techniques; ingenuity in the form of thorough knowledge of the wide and varied paper market. Combined, this know-how pays off in orders printers and their paper men might otherwise lose.

This section discusses the application of ingenious use of paper to help "sew up" printing orders. Case history in nature, the discussion draws upon the experiences of a number of paper men and printers.

The first case considers only the practical importance the "bulk factor" plays in the selection of printing papers for specific requirements.

A Manhattan printer likes to tell this story of an order he saved with the benefit of a paper man's suggestion:

A long-run, large wall-calendar job was involved. The printer's customer specified that the calendar pages be printed on a 20 × 26—65-lb., white, antique-finished cover paper. The brand was identified. This printer and his competitors estimated as instructed. But all estimates exceeded the buyer's budget.

So, estimating began anew. Pencils were sharpened to needle points. Production and estimating staffs huddled to effect economies. Suppliers were called in new consultations.

The successful bidder and his paper man found part of the answer to the over-all estimating problem in the application of paper know-how. Here are the detailed facts for what they're worth to you today, tomorrow, and always:

Paper required for the job amounted to 250,000 sheets size 36 × 48. In terms of 65-lb. basis cover paper, 1000 sheets size 36 × 48 weighed 432 lb.—a total tonnage of 108,000 lb. The price-per-hundredweight was $13.65. The total cost, $14,742.

The caliper thickness of the 65-lb. cover specified read 0.0085. The printer's customer described the surface as antique with a "little tooth." The tone of white required was "blue."

Scratching for savings, the printer and his paper man together developed a paper that clinched the order.

Believe it or not, a vellum-finished, 25 × 38–100-lb. white, offset paper strikingly resembled the antique cover paper. The micrometer read an identical 0.0085. In weight-per-thousand sheets, though, the offset paper showed a saving of 68 lb.—and the price-per-hundredweight benefit was even more startling—it added up to $1.40.

To underscore this over-all saving in paper of better than $3500, study the box score in Table A.

Table A. Offset Substituted for Cover

Quality	*Caliper, in.*	*Size and weight per M*	*Total tonnage, lb.*	*Price per cwt., $*	*Total, $*
Cover	0.0085	36 × 48—432 (20 × 26—65)	108,000	13.65	14,742.00
Offset amt.	0.0085	36 × 48—364 (25 × 38—100)	91,000	12.25	11,147.50

Emerson Magnetic Separators *Trapped!*

Emerson Magnetic Separators improve stock conditions IN ANY MILL by eliminating metal, preventing damage to Jordan fillings, refiners, pumps, screens, cylinder moulds, wires, felts, etc. Magnetic Separators have no moving parts, cannot get out of order, require no extra power — have permanent powerful magnets that operate efficiently with up to 70-pound stock pressure.

Simple to Install Emerson Magnetic Separators for any stock line are equipped with 125-pound class standard cast iron pipe flanges for easy installation. Stocked in 6″, 8″, 10″, 12″ and 14″ pipe sizes.

Easy to Clean Unscrew hand bolts (provided), remove cover, and plates may be either removed or left in the housing for cleaning. Many mills have adapted parallel Separator installations to permit cleaning with no interruption to stock flow.

Built to Last Magnets are cast of Alnico #5, and enclosed in stainless steel boxes, thus preventing any contact of the magnet with other material. Pole pieces are of magnetic steel. After plates pass rigid Emerson plant tests for pulling and holding strength, they retain these qualities indefinitely.

Designed for Efficiency Stock is directed into Emerson Magnetic Separators at an angle to the plates, thinned and fanned out, all within range of the magnetic field, then flows to the outlet without restriction.

Available also

(a) The New Emerson Magnetic Separator Trap for extremely difficult separating problems, such as high stock velocity or heavy stock consistency.

(b) Magnetic Separator Plates in any widths for trough installations.

(c) Many standard sizes in stock. Special sizes on request.

Further information on Emerson Magnetic Separators gladly furnished.

The Emerson Manufacturing Co.

Division of John W. BOLTON & Sons, Inc.

Lawrence, Massachusetts, U. S. A.

Still another classic story bears repeating because it so convincingly focuses attention on the value of "building" papers to order when all else fails. Again the "bulk factor" proves to be the order-clinching ingredient.

For a deluxe "showpiece" publication, the editor had, from the outset, resolutely decided to print the letterpress section on a heavy-weight coated paper, 25 × 38—120-lb. For the offset forms, however, he was counting on an "offset-kind of paper" also 25 × 38—120-lb.

However, none of the original dummies presenting combinations of various brands and qualities hit the bulls'-eye. The editor wanted a bulky publication, a "substantial, hefty book." He wanted both the offset and letterpress sections produced on functionally rigid papers. He hoped the art subjects on some of the pages would be clipped and mounted for framing. Consequently, extraordinary thickness was sought. The papers first presented for the offset section were more supple than rigid. To guarantee the proper caliper thickness, a conventional offset paper in the 25 × 38—150-lb. weight was considered.

It's interesting to recall that at this early date in the making of the book, price wasn't of the essence. Rather, determining the proper paper added up to the major project facing editor, lithographer, binder, and paper supplier.

Came, then, into the picture, still another paper man with an idea that paid off in a contract for the first year's paper requirements. Involved were a little better than 6 carloads of paper—coated and antique.

A good quality, 17 × 22—40-lb. papeterie was recommended. Not just any 17 × 22—40-lb. papeterie, but the specific grade of a mill whose papers are known to be inherently bulky.

The suggestion was sure-fire.

In the eyes of the editor, this paper suitably provided every quality he wanted. The lithographer agreed. And the binder satisfied himself by making a case-bound dummy.

The bulk was high, a substantial 0.009; a "hefty" feel. The proper rigidity was apparent in a flash. There was stiffness not even the vellum-finished offset possessed. But with all that, the paper was flexible enough to make for easy reading.

The tone of white was bright and blue and clean.

Price? Actually, the publisher paid more for the paper he subsequently selected than he would have had he settled for the 25 × 38—100-lb., white, vellum-finished offset paper that calipered 0.00875. The offset paper would have cost him a trifle more than $7400 for the year's supply. The bill the publisher paid amounted to approximately $8500. Until the papeterie had been introduced, though, the publisher had given prominent consideration to the 25 × 38—120-lb., regular, wove-finished offset. Then he had been prepared to purchase the year's requirements for about $8800.

Translated in sizes and weights, and dollars and cents, the story is briefed in Table B.

Table B. Offset Supplied Required Bulk

Quality	*Caliper, in.*	*Size and weight per M*	*Total tonnage, lb.*	*Price per cwt, $*	*Total, $*
Offset reg.	0.007	33 × 50—348	60,552	12.25	7,417.62
vellum	0.00875	(25 × 38—100)			
Offset reg.	0.0085	33 × 50—416	72,384	12.25	8,867.04
vellum	0.010	(25 × 38—120)			
Offset reg.	0.010	33 × 50—522	90,828	12.25	11,126.43
vellum	0.012	(25 × 38—150)			
Papeterie amt.	0.009	33 × 50—348 (25 × 38—100)	60,552	14.20	8,598.38

The identical principle is practiced almost every day by seasoned printers and their paper suppliers. For instance, this additional exhibit of applied ingenuity:

Costs of producing colorful advertising-postcards had followed a spectacular spiral until one of the major users of the medium considered dropping it from his 1950 program. All sorts of substitute measures had been investigated. Each was decided against.

A paper salesman saved the day; saved an order that added up to 20,000 lb. annually—and, incidentally, helped the printer keep the business that otherwise might have slipped away.

The advertiser had, for years, consistently used a good quality, natural-white, vellum-finished printing bristol of a well-known brand. Nothing less would do—until the hero of this story and his bright idea came on the scene.

He helped to sell the advertiser on the value of a 25 × 38—150-lb. cream-tint, vellum-finished offset paper calipering a husky 0.012. Characteristic-for-characteristic, this paper resembled the bristol; missing only was the superior snap and rigidity the bristol provided.

The scorecard tells its own story. The $100 saved in the purchase of paper plus the production economies achieved piled high enough to impress the advertiser (see Table C).

Table C. When Offset Vellum Replaced Bristol

Quality	*Caliper, in.*	*Size and weight per M*	*Total tonnage*	*Price per M sheets, $*	*Total, $*
Offset vellum	0.012	22 × 28—194 (25 × 38—150)	27,000 sheets (5,238 lb.)	27.85	751.95
Bristol	0.012	22 × 28—230 ($22^1/_2$ × $28^1/_2$ —120)	23,000 sheets (5,290 lb.)	37.40	860.20

Many similar stories could be told. However, it's almost 100% certain the thesis is clear—*effectively exploited, the "bulk factor" can serve many useful purposes and contribute many economies if need be.*

Seasoned paper salesmen and seasoned paper buyers, catalog mills, and mill lines according to the "bulk factor."

It's a matter of record that among mills making equivalent grades and qualities, high and low bulk manufacturing limitations vary.

Bulk Determination Scale

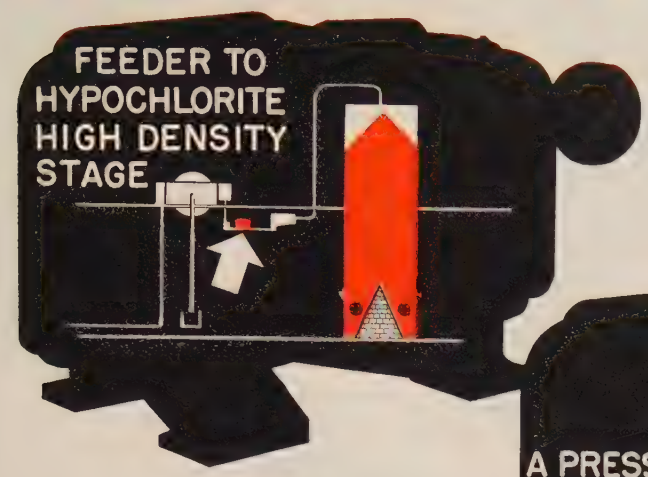
Four sheets of paper measured by the micrometer will require the corresponding number of pages that is opposite the measure to bulk 1 in.

Micrometer measure	*Pages*	*Micrometer measure*	*Pages*
0.042	192	0.014	576
0.039	208	0.0135	592
0.036	224	0.013	608
0.034	240	0.01275	624
0.032	256	0.0125	640
0.030	272	0.01225	656
0.028	288	0.012	672
0.0265	304	0.01175	688
0.025	320	0.0115	704
0.024	336	0.01125	720
0.023	352	0.011	736
0.022	368	0.01075	752
0.021	384	0.0105	768
0.020	400	0.01025	784
0.0195	416	0.010	800
0.019	432	0.00975	816
0.018	448	0.0095	832
0.0175	464	0.00925	848
0.017	480	0.009	880
0.0165	496	0.00875	912
0.016	512	0.0085	928
0.0155	528	0.00825	960
0.015	544	0.008	992
0.0145	560	0.00775	1008

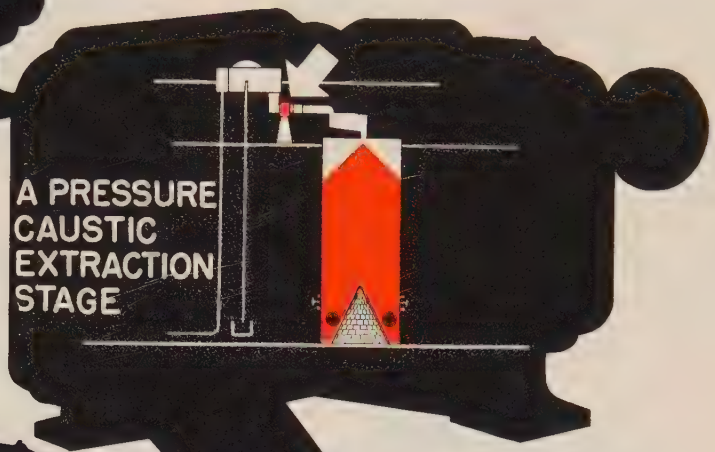
BULK DETERMINATION

To determine the bulk of a given number of pages: caliper

THICK STOCK PUMP

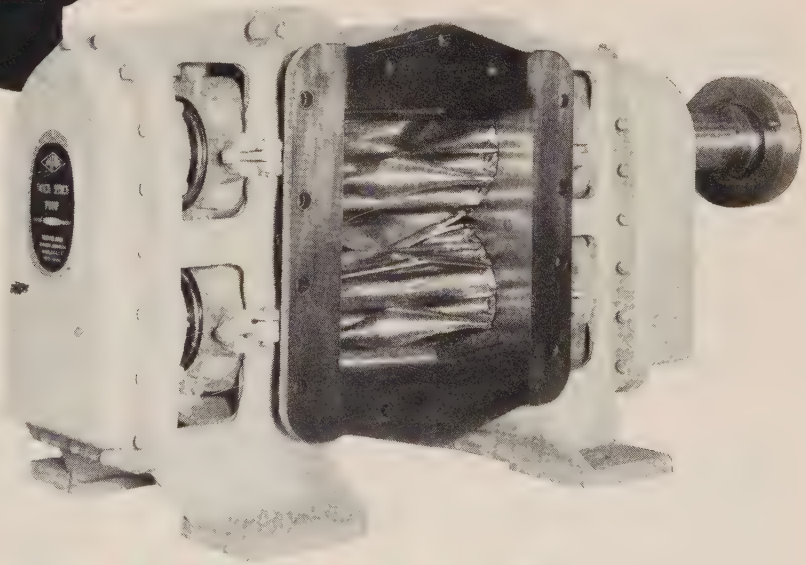


PUMPING 10%-17% PULP



IMPCO

SERIES - 300 *
SERIES - 500 *



This unit is a positive displacement type pump specifically designed to handle pulps at high densities. The conical profile of its synchronous rotors permits the pumping of stock at densities above 10% A.D. — with lowest horsepower per ton — and no fibre damage. Truly the modern way to handle all types of pulp.

* Tons per day.

IMPROVED MACHINERY INC.

J-35

NASHUA, NEW HAMPSHIRE

Sherbrooke Machineries Limited manufacture similar equipment in Canada.

eight pages, multiply the amount of points by the given number of pages; then divide by eight.

Example: Eight pages caliper 0.020. What will 320 pages bulk?

$$\begin{array}{r} 320 \\ \times 0.020 \\ \hline 6.400 \end{array} \qquad 8 \overline{)\,6.400}\ \ 0.800$$

Answer: 0.8 or approx. 3/4 in. plus.

To determine the number of pages per inch: caliper eight pages; divide the number of points into 8000.

Example: Eight pages caliper 0.016.

$$0.016 \overline{)\,8000}\ \ 500$$

80

Answer: 500 pages to 1 in.

It's no secret that standard, mill-brand papers of some manufacturers are, weight-for-weight and quality-for-quality, distinctively more bulky than papers made at other mills.

The advertised brands of one prominent paper manufacturer, for instance, are known to be bulkier, pound-per-pound, than many competitive grades. Included among the papers are: English finish, eggshell, text, and offset.

It goes without saying, there are numerous occasions when the "high-bulk factor" is not important. Just as often as not, requirements call for low-bulk, smooth-finished papers. Therefore, it is just as important to know which papers grade-for-grade favor low-bulk characteristics.

It's not difficult to catalog papers according to the "bulk factor" plan. From your own experience, you can develop a useful fund of information.

Bulks—Approximate Pages to Inch

	60	*70*	*80*	*90*	*100*	*120*
Coated						
Lustro gloss, Cumberland gloss, Offset enamel, Westbrook gloss	720	618	540	480	432	360
Lustro dull, Cumberland dull, Offset enamel dull	...	572	500	444	400	334
	40	*45*	*50*	*60*	*70*	*80*
Uncoated						
Printone	...	...	752	660	578	460
Cumberland E.F.	760	738	664	554	474	416
"1854"	688	586	528	440	378	330
Olde style	...	...	470	392	336	294
No. 66	480	426	384	320	274	240
Silkote offset	...	...	576	480	412	360
			20	*24*	*30*	*35*
Thin Papers						
Thintext			1420	1184	1030	...
Bibliopake			...	...	1000	888

THE EQUIVALENT WEIGHT FACTOR

The printer couldn't buy a 20 × 26—80-lb. cover paper in size 26 × 40. He had shopped all over town, he said. By his own count, he had phoned 14 paper merchants.

One merchant among those contacted, saved the day for the printer and the dollars for the paper salesman calling on the account. Like the other 13 merchants, the 14th didn't have the exact paper the printer wanted. But he could, he said, supply an "all-purpose" kind of bristol and cover paper in size 26 × 40—330M. One thousand sheets of genuine cover paper weighs 320 lb.

As a result the 14th paper merchant wrote the order for 20,000 sheets. Twenty times 330 represents 6600 lb. of paper, a highly desirable order that might otherwise have been lost. At the price of $16.10 a hundred pounds, the total sale mounted to $1062.

And the printer went to press.

That's just one illustration of paper-marketing know-how at work using *the equivalent weight factor.*

We like to tell that story because it was volunteered by a printer during a trade meeting. The incident occurred several years ago, but the impact of the experience remained crystal clear in the printer's memory. So clear that the paper merchant today enjoys a considerable volume of business he might never have enjoyed had it not been for the alertness of the man on his company's order desk.

Here's another example of applying the principles of equivalent weight.

A printer needed 27,000 lb. of a 25 × 38—30-lb. sulphite Bible paper but he couldn't get it quickly enough. He canvassed his regular suppliers of lightweight papers, typical Bible papers and lightweight English finish book papers. But without avail.

One paper merchant—never before considered as a supplier—found the answer in the use of a 17 × 22—11-lb. sulphite bond paper. Now, 11-lb. bond is equivalent in weight to a 25 × 38—28-lb. book paper. So, reasoned the paper merchant, when he learned that the paper would be used for the pages of large wall calendars, the substantial feel, the 0.00225 caliper, and the hard-sized surface characteristics of the bond paper could prove even more desirable for the purpose than the English finish book paper or the Bible paper.

To make a long story short, the order was placed for the 11-lb. bond paper and it subsequently proved beneficial on more counts than just availability. The printer found it especially pressworthy and the printer's customer expressed overall approval. That the printer also toted up a $100 saving when all the returns were in is also a point worth remembering.

For the record, here are some pertinent facts taken from the printer's estimate form:

Quantity.....315,000 sheets (25,000 lb.)
Size and weight.....31 × 43½—80M (17 × 22—11)
Grade.....Sulphite bond
Color.....White
Grain.....43½ in. dimension
Packing.....Trimmed four sides, ream-marked on skids
Price per cwt.....$14.50
Total price.....$3654

The 25 × 38—30-lb. book paper would have weighed 27,090 lb., approximately 2000 lb. more than the bond. The price per hundredweight would have been somewhat lower; actually $13.85, compared to the $14.50 price for the bond. The total price for the book paper would have been $3751.96.

Seasoned printers and their paper suppliers practice this identical principle every day. With them it's practically "second nature" to trade on the benefits of *the equivalent weight factor.* Nevertheless, it's not a little surprising to know how seldom this fundamental of paper marketing is exploited.

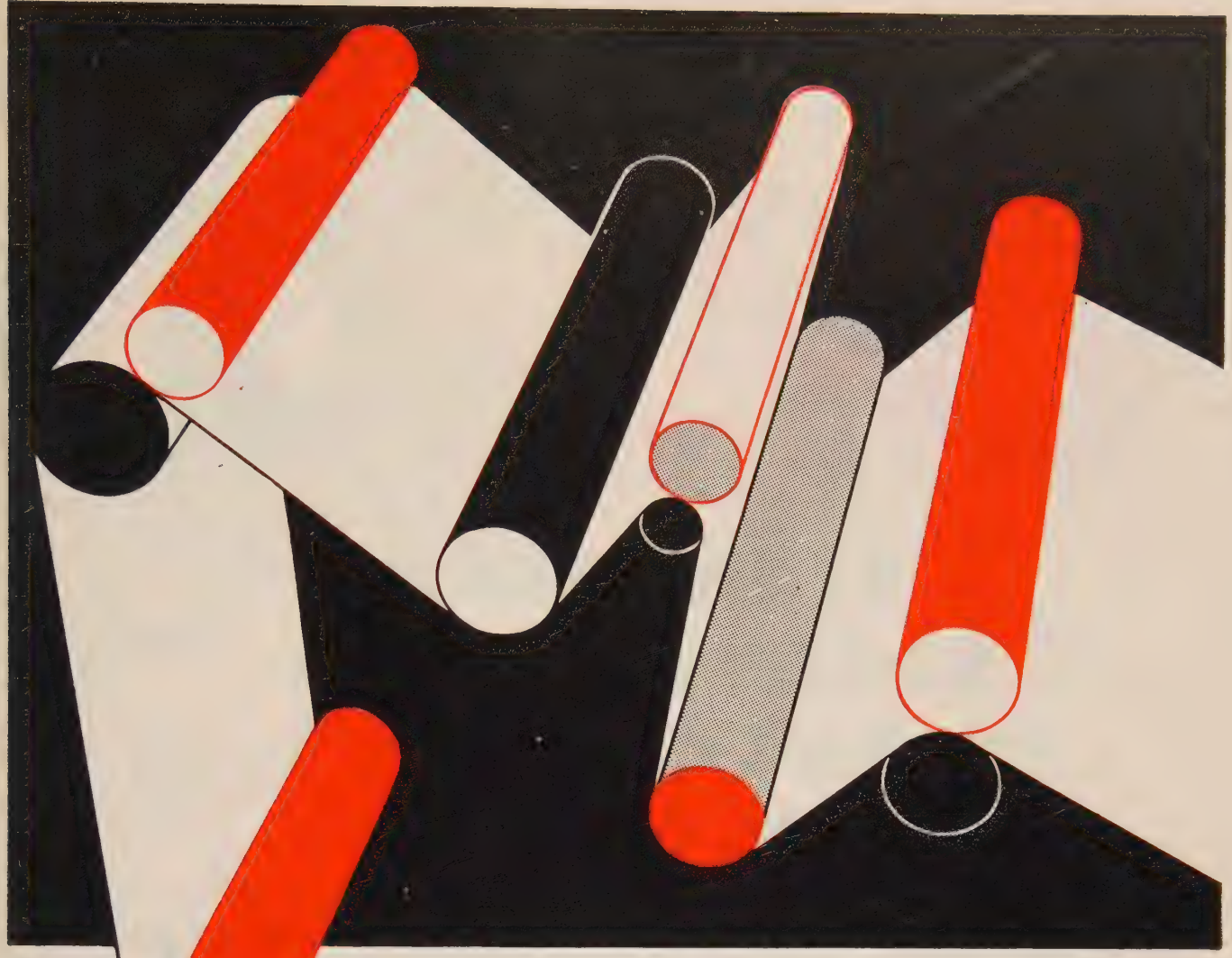
For that reason alone it pays to study even as obvious an example as this is of the equivalent weight factor so effectively at work.

Comparable Weight of Various Grades

Knowing which weights of book paper, for instance, are comparable to (equivalent to) bond papers, vellum papers, cover papers, is good business because using one for the other often represents the difference between saving and losing an order. Applying the "equivalent weight" factor to all paper problems is required practice.

Table of Equivalent Weights

Bond:	Offset:	Book:
Basis 17 × 22—20	25 × 38—51	25 × 38—51
17 × 22—24	25 × 38—61	25 × 38—61
17 × 22—28	25 × 38—71	25 × 38—71



Lasting Crowns—More use per Dollar

MANHATTAN RUBBER COVERED ROLLS

• OUR NEW NEENAH, WIS. PLANT IS DESIGNED FROM THE GROUND UP TO HANDLE ANY SIZE ROLL COVERING MOST EFFICIENTLY.

You save money on rolls and lower your production costs because you get perfect and durable crowns to *your* specifications . . . Just the right density . . . Just the precise dimensions you demand. That's because Raybestos-Manhattan custom-covers roll cores to meet the special needs of your plant. Manhattan Rubber Covered Rolls hold their crowns longer and their density permanently, giving you uniform, trouble-free production. Talk it over with the R/M specialist nearest you, next time you need rolls rubber covered.

ROLL COVERING PLANTS AT PASSAIC, N. J. — NEENAH, WISC. — NORTH CHARLESTON, S. C.

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings
Asbestos Textiles • Teflon Products • Packings • Sintered Metal Parts • Bowling Balls

MR-911

Table of Equivalent Weights (*Continued*)

Vellum:	Offset:	Cover:
Basis 17 × 22—32	25 × 38—81	20 × 26—45
17 × 22—36	25 × 38—91	20 × 26—50
17 × 22—40	25 × 38—102	20 × 26—56
17 × 22—44	25 × 38—112	20 × 26—60
Index:	Offset:	Cover:
Basis 20½ × 24¾—72	25 × 38—110	20 × 26—60
20½ × 24¾—91	25 × 38—135	20 × 26—74
20½ × 24¾—111	25 × 38—170	20 × 26—93
Coated cover:	Coated Bristol:	
Basis 20 × 26—80	22½ × 28½—0.008	
20 × 26—100	22½ × 28½—0.010	

How to Find the Ream Weight of Special Sizes

Your equivalentor scale is a handy gadget to have around when you want to know the weight per thousand sheets of a special paper size. Determining the unknown weight is accomplished quickly.

However, when your equivalentor is not at your finger tips don't be dismayed, use this little formula:

$$\frac{\text{sheet area of desired size} \times \text{basic weight}}{\text{sheet area of basic weight}} = \text{equivalent weight}$$

For instance—find the weight per thousand sheets of size 30 × 43 25 × 38—50-lb. offset:

$$\frac{30 \times 43 \times 50}{25 \times 38} = 67.89 \text{ lb.}$$

or

$$\frac{1290 \times 50}{950} = 67.89 \text{ lb.}$$

There is a handy table—a table of factors that makes your arithmetic even simpler.

The factor for 50-lb. book paper is 0.05263. Multiply the factor by 1290 sq. in. The answer is 67.89270.

For your ready references here is the factor table you can use often to speed up your estimating:

To find the approximate ream weight of any special size—multiply sheet length by width thus determining the square inch area of the special size sheet. Multiply this area by the weight factor shown in the tables below.

Book Paper

Ream of 500 sheets
Sub. (25 × 38 basis)

30 Multiply the square inch area of the special size by 0.03158
35 Multiply the square inch area of the special size by 0.03684
40 Multiply the square inch area of the special size by 0.04210
45 Multiply the square inch area of the special size by 0.04737
50 Multiply the square inch area of the special size by 0.05263
60 Multiply the square inch area of the special size by 0.06316
70 Multiply the square inch area of the special size by 0.07367
80 Multiply the square inch area of the special size by 0.08421
100 Multiply the square inch area of the special size by 0.10526
120 Multiply the square inch area of the special size by 0.12631

Writing

Ream of 500 sheets
Sub. (17 × 22 basis)

13 Multiply the square inch area of the sheet by 0.0348
16 Multiply the square inch area of the sheet by 0.0428
20 Multiply the square inch area of the sheet by 0.0535
24 Multiply the square inch area of the sheet by 0.0642
28 Multiply the square inch area of the sheet by 0.0749
32 Multiply the square inch area of the sheet by 0.0856
36 Multiply the square inch area of the sheet by 0.0962
40 Multiply the square inch area of the sheet by 0.1070
44 Multiply the square inch area of the sheet by 0.1177

Cover Paper

Ream of 500 sheets
Sub. (20 × 26 basis)

25 Multiply the square inch area of the special size by 0.0480
35 Multiply the square inch area of the special size by 0.0673
40 Multiply the square inch area of the special size by 0.0769
50 Multiply the square inch area of the special size by 0.0961
65 Multiply the square inch area of the special size by 0.1250
80 Multiply the square inch area of the special size by 0.1539
90 Multiply the square inch area of the special size by 0.1730

Bristol and Postcard

Ream of 500 sheets
Sub. (22½ × 28½ basis)

91 Multiply the square inch area of the special size by 0.142
100 Multiply the square inch area of the special size by 0.156
105 Multiply the square inch area of the special size by 0.164
115 Multiply the square inch area of the special size by 0.180
120 Multiply the square inch area of the special size by 0.187
130 Multiply the square inch area of the special size by 0.203
140 Multiply the square inch area of the special size by 0.218
150 Multiply the square inch area of the special size by 0.234
160 Multiply the square inch area of the special size by 0.250
180 Multiply the square inch area of the special size by 0.280
200 Multiply the square inch area of the special size by 0.312

Index

Ream of 500 sheets
Sub. (20½ × 24¾ basis)

58½ Multiply the square inch area of the sheet by 0.1153
72 Multiply the square inch area of the sheet by 0.1419
91½ Multiply the square inch area of the sheet by 0.1803
111 Multiply the square inch area of the sheet by 0.2188
143 Multiply the square inch area of the sheet by 0.2838

Handy Table of Square Inch Areas of Basic Paper Sizes

17 × 22	374 sq. in.—bond, ledger, writing, vellum	22 × 28	616—blank
		22½ × 28½	641—tag
18 × 31	558—manuscript cover	22½ × 35	787—bristol
19 × 24	456—blotting	25 × 38	950—book
20 × 26	520—cover paper	25½ × 30½	778—index

Comparison of Cost of Standard Sizes and Special Sizes (Book Papers—2000 to 5000 Lb.)

The differential for special sizes in lots of 2000 to 5000 lb. is 10%. In many cases the adding of this differential makes a special size order cost more than the same number of sheets in the next larger standard size. Often, therefore, it is cheaper to order the next larger standard size.

This table shows you advantageous sizes to buy:

Standard 38 × 50
If you require a special size in between these two buy 38 × 50. For example: 36½ × 48½ with the 10% differential added will cost more than 38 × 50.

Standard 36 × 48
The standard size 36 × 48 is cheaper than a special size 35½ × 45½.

Standard 35 × 45
If you need 32½ × 44½ you can buy 35 × 45 for the same price or slightly less.

Standard 32 × 44
If you require a special size 29 × 44 you can buy 32 × 44 for the same price. 29½ × 44 will cost more than 32 × 44.

Standard 28 × 44
The 28 × 44 is cheaper than any special size down to the next standard 28 × 42.

Standard 28 × 42
A special size 26½ × 41 will cost as much as the standard size 28 × 42. For sizes between 26½ × 41 and 28 × 42 buy the 28 × 42 as a saving in money.

Standard 26 × 40
Any special size in between 26 × 40 and 25 × 38 will cost more than 26 × 40. Buy 26 × 40 as a saving.

DU PONT PIGMENT COLORS

for

- WALL PAPER
- COATED PAPER
- FLINTED PAPERS
- BEATER DYEING

STANDARDIZED PIGMENTS TO MEET THE EXACTING REQUIREMENTS FOR PAPER COLORING

THE DU PONT LINE includes economical pigments of highest quality. There are colors for beater dyeing which have been especially processed for quick and thorough dispersion in water. They have better strength than the usual lakes for beater coloring. Use them for papers which must have good lightfastness.

All these Du Pont pigments are standardized for properties important to their use in paper. They may be adapted to the most exacting requirements.

You can get further information from your Du Pont salesman, or by writing to E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, 1007 Market Street, Wilmington 98, Delaware.

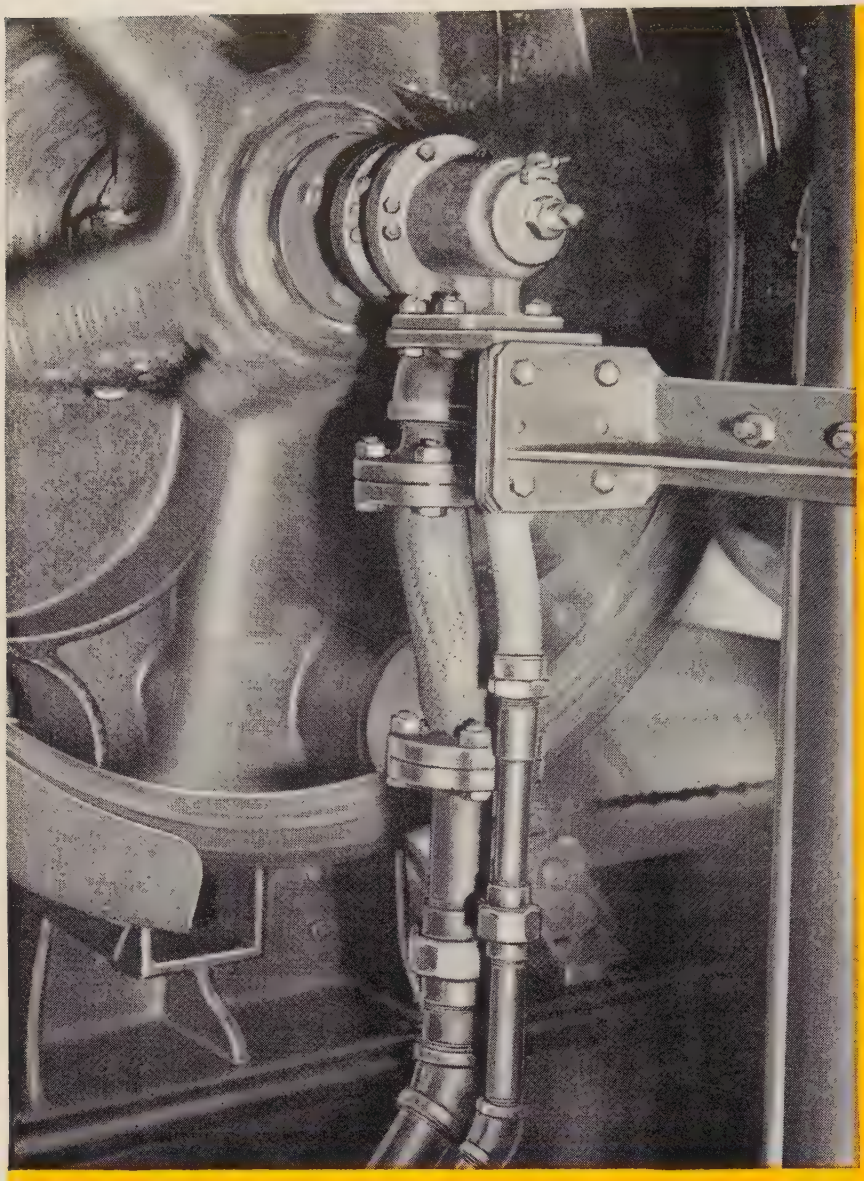
USE THESE DU PONT PIGMENTS FOR QUALITY PRODUCTION

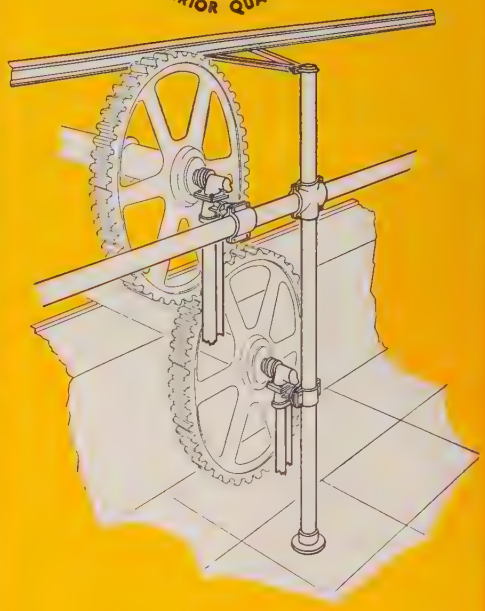
Chrome Yellow • Organic Yellow Lakes • "Watchung" Red
Pigment Green B—full strength and lakes • Molybdate Orange
Dispersible "Monastral" Blue and Green Lakes • Toluidine Red
PTMA—Green and Red Lakes

DU PONT

Better Things for Better Living ... through Chemistry

DU PONT PIGMENTS FOR PAPERS





At left: Puseyjones Improved Steam Joint with adjustable single drop-type siphon on Dry Part having open-type gearing. Flexible pipe connections incorporated in steam and water piping compensate for expansion or contraction in supply headers or branch connections.

Above: Special outside pipe structure required for modernization of Dry Part having open-type gearing.

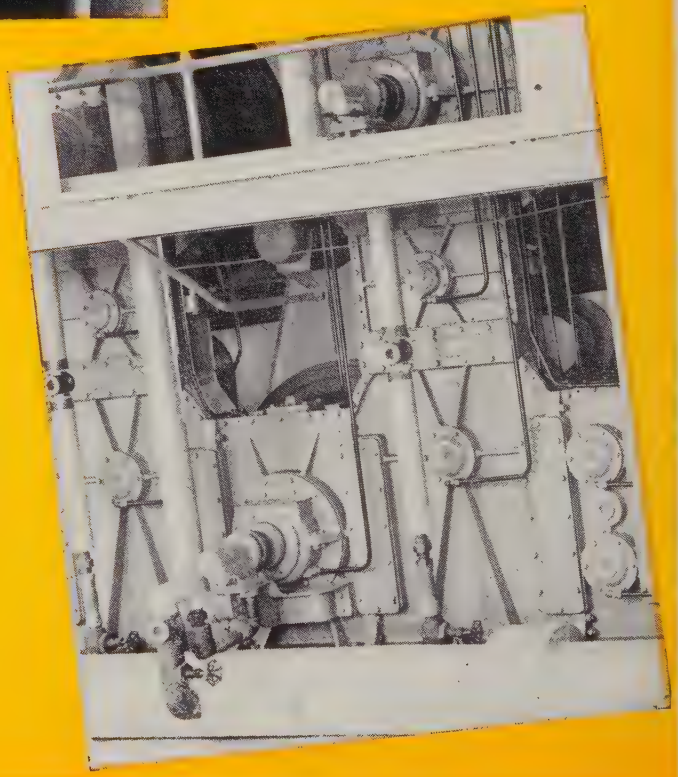
Puseyjones Improved Steam Joint with dual revolving-type siphon on new Dry Part having enclosed type gearing.

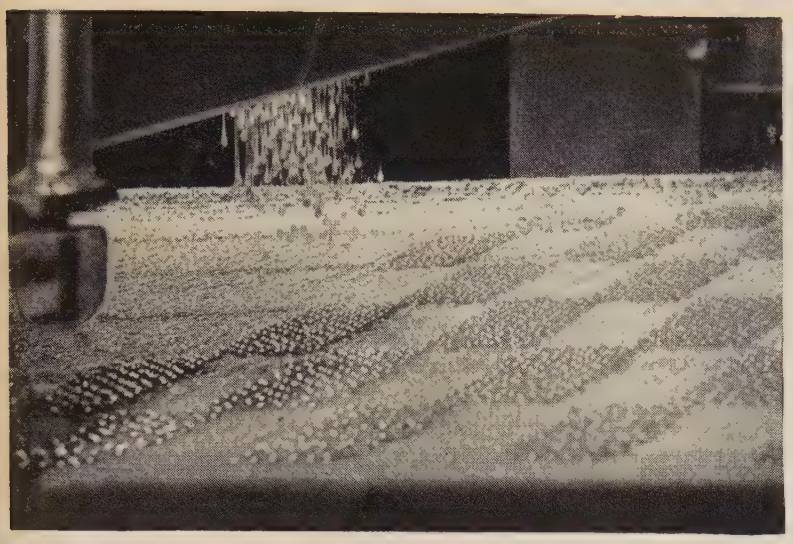
Modernize with NEW PUSEYJONES STEAM JOINTS

When condensate drainage is slow and inadequate, operating speeds and drying rate are reduced. Power losses on your paper machine may range as high as 50%.

A machine modernization program with Puseyjones Improved Steam Joints is the first step in reducing power costs, increasing the drying rate and stepping up production. Many mills have discovered the advantage of keeping drying cylinders filled with steam through efficient condensate drainage. For complete information, let us send you a copy of the "Steam Joint Bulletin." Write today or call our District Representative near you.

THE PUSEY AND JONES CORPORATION
Established 1848 : : Builders of Paper-Making Machinery
Fabricators and Welders of all classes of Steel and Alloy Products
Wilmington 99, Delaware, U.S.A.





Just one phase of Swift's exclusive process—the glue liquor falls on a bed of dry finished product and moves through a virtually closed drying system. No chance for contact with contaminating substances.

Attention paper producers!

Only Swift can give you New Process Glue

A product of unexcelled purity and uniformity, New Process Glue is *exclusive* with Swift. Only Swift has the facilities to manufacture this quality glue for paper makers.

In Swift's exclusive process, protein liquor is scientifically extracted from fresh, selected raw material. The concentrated liquor falls in drops on a moving belt of dry glue. Then, by continuous and automatic process, the product is dried, milled and screened. During the entire manufacturing process and in finished form, the product must pass rigid laboratory tests . . . meet a number of chemical and physical requirements.

Uncontaminated by foreign substances—New Process Glue is a clean, light-colored, uniform product.

Here's where Swift's New Process Glue serves the paper producer

● ***IN PIGMENT RETENTION*** — The flocculating action of New Process Glue promotes high retention of clay and titanium pigments . . . keeps fiber and filler on the wire of the paper machine . . . helps increase the brightness and opacity of filled papers . . . promotes better fiber formation, aiding in the production of a denser, stronger sheet.

● ***IN FLOTATION-TYPE SAVEALL SYSTEMS*** — New Process Glue helps obtain clearer effluents because of its unusual ability to flock fibers and fillers.

● ***IN GETTING HIGHER PICK TEST*** — New Process Glue is used as a partial replacement for starch in machine coating. It promotes better film formation and greater tensile strength than a total starch solution.

SWIFT & COMPANY
Adhesive Products Department
Chicago 9, Illinois

Please send your 100-lb. introductory shipment of Swift's New Process Glue at the quantity price, to be tested for use in our operations. We understand, if not fully satisfactory, it may be returned for credit at your expense.

*Name*_____ *Title*_____

*Firm Name*_____

*Address*_____

*City*_____ *Zone*____ *State*_____

This offer expires November 30, 1953

Call SWIFT first for GLUES

Standard 25 × 38
Buy the 25 × 38 size as more economical than any size in between these two.

Standard 24 × 36
Buy the 24 × 36 size. It is more economical than any special size between these two.

STRENGTH AND DURABILITY FACTORS

"You didn't tell me the paper wouldn't score well against the grain." Buck Jones the printer was fit to be tied.

Sam Spade, paper salesman, lashed back, "You didn't ask me. You specified grain long. I assumed you planned it that way."

But for the timely assistance of ingenious Bill Shapiro, binder, the goodly quantity of expensive paper discussed here might have been doomed to the waste bag—almost $1000 worth; beautifully printed four-color process and press scored.

The printed sheets were to cover an attractive-looking, give-away, 48-page, bridge score pad. But the moment the saddle wire stitches pierced the cover paper, it cracked wide open like an ice floe in the Spring.

Making a long story short, Binder Bill found a way to save the day and the cost. On his stitching machine, and in one operation, mind you, he skillfully contrived to spot-gum the first and last pages of the pad to the inside front and back covers. Final result—everyone happy and just a little bit wiser.

What is the lesson—or lessons—to be learned from this incident?

First, know that the cover paper was 0.010 coated bristol.

Buck and Sam knew that the paper eventually would be folded. They knew the fold was short—the pad sheet-size was only 3 in. by 6 in., binding the 3-in. dimension. They were aware that the stress on the fold would be great, because the pad was unusually bulky at the binding edge. Sam's service department, when making the dummies, made it a point to underscore that condition and they urged that special pains be taken to prevent cracking.

Yet Buck and Sam each took it for granted that the other had considered all the production problems.

Scoring 0.010 coated bristol and other coated bristols wasn't new to his shop, Buck said. He saw no reason why, in this situation, processing should be any different. He volunteered that earlier scoring tests had not been as severe, however. Then he had been producing one-fold menus and die-cut table tents. Pressed further for details, Buck indicated ordinary narrow-gage scoring rules had been used.

Had Sam been on the ball that day, he could easily have reminded Buck that seasoned handlers of 0.010 bristol overcome many folding problems by following scoring suggestions the makers of bristol set down. This is the way they put it: "*It is recommended that a wider score be used than for ordinary run of work. String scoring has proved very effective when used.*" Twenty-three little words, which, if considered, could have prevented the Buck-and-Sam crisis.

Experience keeps a dear school—that's the point we are trying to drive home. But expert application of paper know-how helps to eliminate trouble.

Let's review a few cases of paper know-how at work with *strength* and *durability* factors used to best advantage. Please forgive *obvious* references to strength and durability factors. We include them in this round-up because they are often forgotten.

Case No. 1. A greeting card publisher supplies its house-to-house canvassers with large, accordion-style samplers showing the complete line of cards. For years these samplers were printed on antique finish cover papers; now and again on leather-embossed cover and hard-wearing pyroxylin leatherette cover. But results were never entirely satisfactory. The samplers fell apart too soon.

A new paper salesman calling on the publisher suggested a very obvious corrective measure. The publisher can't understand yet why he hadn't thought of the idea first.

"Why not use a tag stock?" was the question the paper salesman asked. "Yes, why not!" The publisher was in instant and amazed agreement.

Case No. 2. A pattern book on the counters of drygoods stores and piece goods departments in department stores takes a severe beating from women shoppers.

The index pages, particularly, must be extra strong and durable, to withstand even average treatment.

One of the publishers in the field recently decided to dress up the index pages of his book. Designers went to work with color, with elaborate and highly stylized wash drawings. Sturdy old jute manila tag no longer belonged. White-page background was called for . . . but the printers and the lithographers called in on the job threw up their hands when asked to print the intricate design on white tag stock. All kinds of white bristols—strong folding bristols—were considered. None were found strong enough.

Another paper man was called in. His idea paid off. "Use a tough check," he suggested. The recommendation was interesting . . . but the publisher wasn't too excited about the coated-two-sides feature of the stock. Only type was printed on the underside of the sheet; and occasionally corrections were made with pen-and-ink or with rubber stamp.

"That's easy to take care of," the paper man said. "We'll just coat one side of the tag." And that's the way the order was subsequently placed.

Case No. 3. This story isn't about printing papers, although the paper was eventually printed. Libraries of transcriptions in radio and television studios are in constant use—"Manhandled" was the way the prospect described the end use of the index cards. "Dividers," he called them. All kinds of materials had been tried—blanks, fiberboards, pressboards; even plastics. Some were satisfactory, most were not. For the syndicated transcription library in question, the most satisfactory materials cost too much. So, only paper products were considered.

When called in, the hero of this piece, like most of his fellow paper men, recommended all the conventional papers and paperboards. None were new—or satisfactory—to the prospect, the salesman soon learned.

He begged for time.

Two days later, he returned with a complete dummy set of dividers made from a 0.020 hard-wearing beaming paper. (Beaming paper is a water-finished kraft paper used by the silk industry for winding strands of silk on the "beam" before weaving.)

Result—beaming paper was selected.

Quick Guide to Folding Qualities

While most papers fold satisfactorily with or against the grain, folds against the grain are not as smooth and even as folds with the grain direction. It is desirable, whenever possible, to print with the grain direction serving its *best* function. True, scoring can help strengthen folds against the grain, but extra cost is involved and the end result is not always satisfactory.

These new facts may be helpful in specifying grain directions for best-possible folding:

COATED BOOK—Top grades of most manufacturers are considered strong-folding papers suitable for broadsides, folders, self-cover booklets, text pages for casebound books, etc. Lower grades and machine coated papers, are not usually recommended where severe folding is required.

COATED COVER—Most papers in this classification are considered of strong-folding quality. Especially satisfactory for typical cover use, for gatefold, for French fold, for Japan fold requirements; for multifold portfolios; for use in mechanical binding operations.

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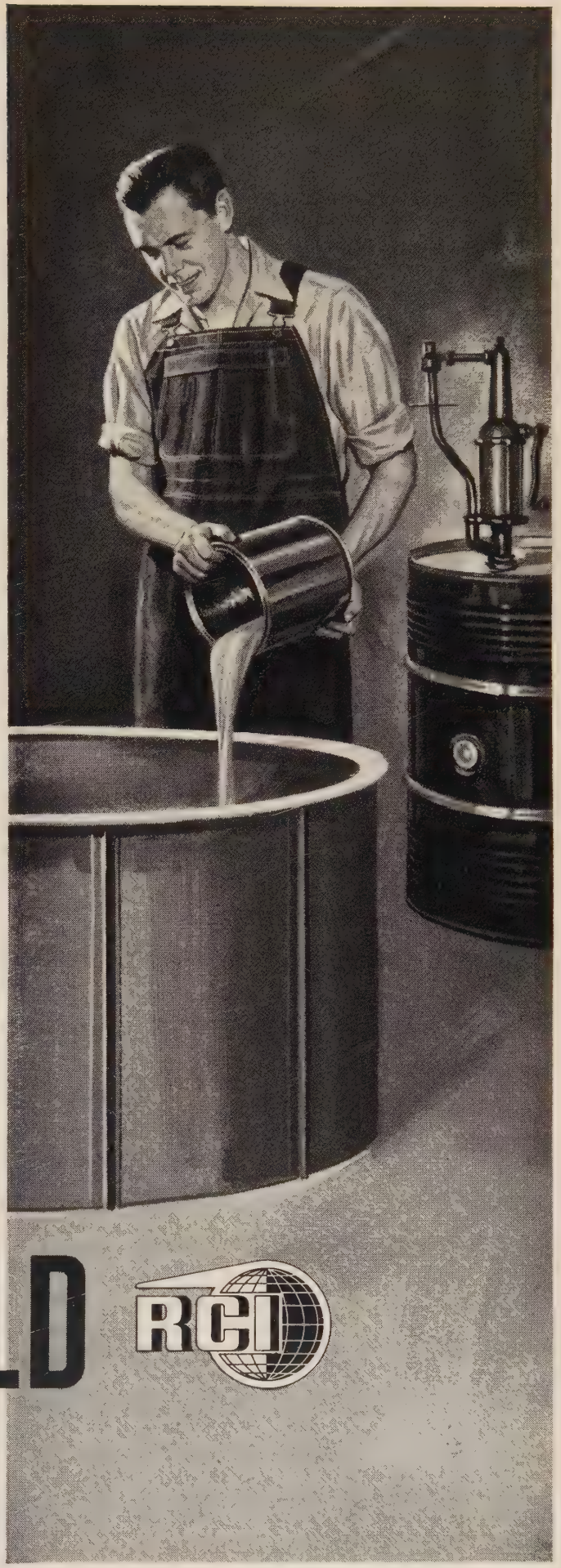

Leather Embossed Cover—These covers are embossed on tough base stock and are ideal when folding qualities are required. Scoring against grain recommended.

Tough Check, Coated Tag—Enameled coating on jute base stock and coated cover papers are ideal for hard-wearing cover paper requirements. Especially satisfactory for mechanical binding where backbone must be retained. Excellent folding qualities with and against the grain. Scoring against grain is recommended.

Folding Bristol—Long, tough fibers make these bristols suited to hard-handling with or against the grain.

Tag—Tags and rope bristols are made exclusively for hard-wear and special-duty purposes.

Antique Cover—50, 65, and 80-lb. cover papers fold well with and against the grain. Double-thick cover paper should always, however, be scored against the grain.

Simulated Leather Cover—These covers fold especially well with or against the grain. For best practical results and for appearance sake, scoring against the grain is recommended.

Strength and Durability

While most papers are substantial in nature, some standard papers are particularly suited for hard or specialized usage. This check list identifies some of these papers and indicates some purposes they may be put to:

Tag—Jute and rope are extremely serviceable.

Tough Check—Coated surface on strong base stock, tough check represents the last word in hardiness.

Antique Cover Paper—Papers made from sulphate (kraft) fibers provide a high degree of strength and longevity.

Leather Embossed—Good quality leather-embossed covers are made on jute rope or sulphate base stocks and therefore assure great strength and wearability.

Simulated Leather—Rate high among strong cover papers. Special base stocks and pyroxylin (plasticized) surfaces combine to add strength and long-wear factors. Most are water and grease repellent; may be cleaned with dampened cloth.

Folding Bristol—Good quality sulphite papers made to specialized folding qualities are highly satisfactory for many advertising purposes that require special handling. Especially suitable for die-cut and pop-up folders.

Rag-Content Index—50% and 100% rag content index bristols are strong, serviceable, and long-lasting.

Rag-Content Bond and Ledger—50, 75, 100, and extra 100% rag-content bond and ledger papers are principally used when long-lasting qualities are of principal consideration.

Plastic Coated Cover—These are multipurpose papers. Gaily decorative, they are also serviceable, waterproof, and stainproof, may be cleaned with a dampened cloth.

Vegetable Parchment—These sheets are waterproof and greaseproof; especially serviceable in food packaging where wet-strength characteristics are essential.

Posting Ledger—Bookkeeping machinery requires highly specialized ledger papers. Rugged, rigid qualities are essential.

End Papers—Strictly strong sulphate papers that withstand hard wear at the front and back folds of books.

Grain Direction

This check list will help you determine the preferable grain direction needed when paper is to be used for some specific purpose:

- ☐ first fold in broadsides.
- ☐ tinning dimension of calendars.
- ☐ binding dimensions of books and magazines.
- ☐ vertical direction for counter cards and window displays.
- ☐ horizontal direction for standard-size car cards.
- ☐ binding dimension of mechanically bound books and presentation portfolios.
- ☐ horizontal direction for labels.
- ☐ opposite direction of fold for pop-up and other "action" kind of folders.
- ☐ direction of platen for typewriter and business machine use.
- ☐ long dimension of paper to be lithographed. With this exception—when the paper being lithographed is manifold, onion skin, or Bible. Then short-grain is recommended for most efficient production.

ASSOCIATION OF COLOR WITH FINISH AND GRADE

When you can identify the finish of a paper, you can almost always identify its color range. Did you know that?

When you can identify the kind of paper—i.e., the classification in which it falls—you can almost always identify its color range. Did you know that? Well, you can.

Seasoned paper buyers and paper marketers long have associated colors with finishes to help them quickly select proper papers for specific purposes.

A "mental short-cut," one paper man calls this technique. For years, he has been dreaming-up short-cuts to help make the lot of the paper buyer easier. Here's one of his pet illustrations when he talks about the connectives between colors and finishes.

"Don't brand names like *Beau Brilliant, Tweedweave,* and *Andorra* call to mind very definite appearance characteristics?" He answers his own question, "Of course they do."

"In finish, for example, isn't the surface of each of these grades rough handmade in nature? Each is distinctively felt-marked. I grant you. But the papers are similar enough to be cataloged as a group of text and cover papers.

"Each brand trades on the individuality of its color range, which isn't unusual among paper merchandisers. Attractive colors represent the personality of papers like these. Some colors are gay; some are somber. Yellows are brilliant. Reds are vivid. Red-oranges are flaming. Blues are usually bright, and deep. Browns, grays, greens are rich and dignified. Maroons and purples are regallike."

Prove these claims to yourself. Double-check your sample swatches to refresh your recollection of these papers and any others that come under the same heading.

While you're in the test-making frame of mind, how about investigating another case in point? Like this:

Examine a selection of popular text papers—to name a few, *Beckett Text, Victorian Text,* and *Strathmore Text.* Compare them finish-for-finish and color-for-color. What do you find?

That, by and large, the color range of each paper shows true pastel tints of blue, green, gray, buff, pink, tan, yellow, warm ivory, and white on the natural side. The colors of these grades are not identical. As pointed out in the discussion of the *Beau Brilliant, Tweedweave, Andorra* group, the manufacturers of these grades market distinctive shades. They're the essential "points of differences" between the papers.

You'll also find that the surfaces of each are similar in appearance. Notice the distinguished antique "limited editions" look in almost identical wove and laid finishes. And the rich-looking, feathery deckle edge.

It's a fact, you can continue on down the list of most of the papers you use every day, applying the same association principles to your personal benefit.

Here's still another example worth studying for the lesson it teaches:

When you're planning a printed job with imitation leatherette cover papers in mind—papers like *Marco, Marvelhide,* and *Marvelleather,* to name three—your color collection is confined to sedate, extra-serviceable shades, like deep browns, blues, greens, reds, and maroons, grays, orange-reds. As you know from experience, most colors in lines like these are solid. A few, though, are two-toned. But basically, the color ranges of each brand are serviceably somber.

Not so the color ranges of leather-embossed cover papers—like *Hammermill Cover, Riegel's Jersey,* and *Buckeye Cover,* just to identify some typical cover papers that are available especially embossed.

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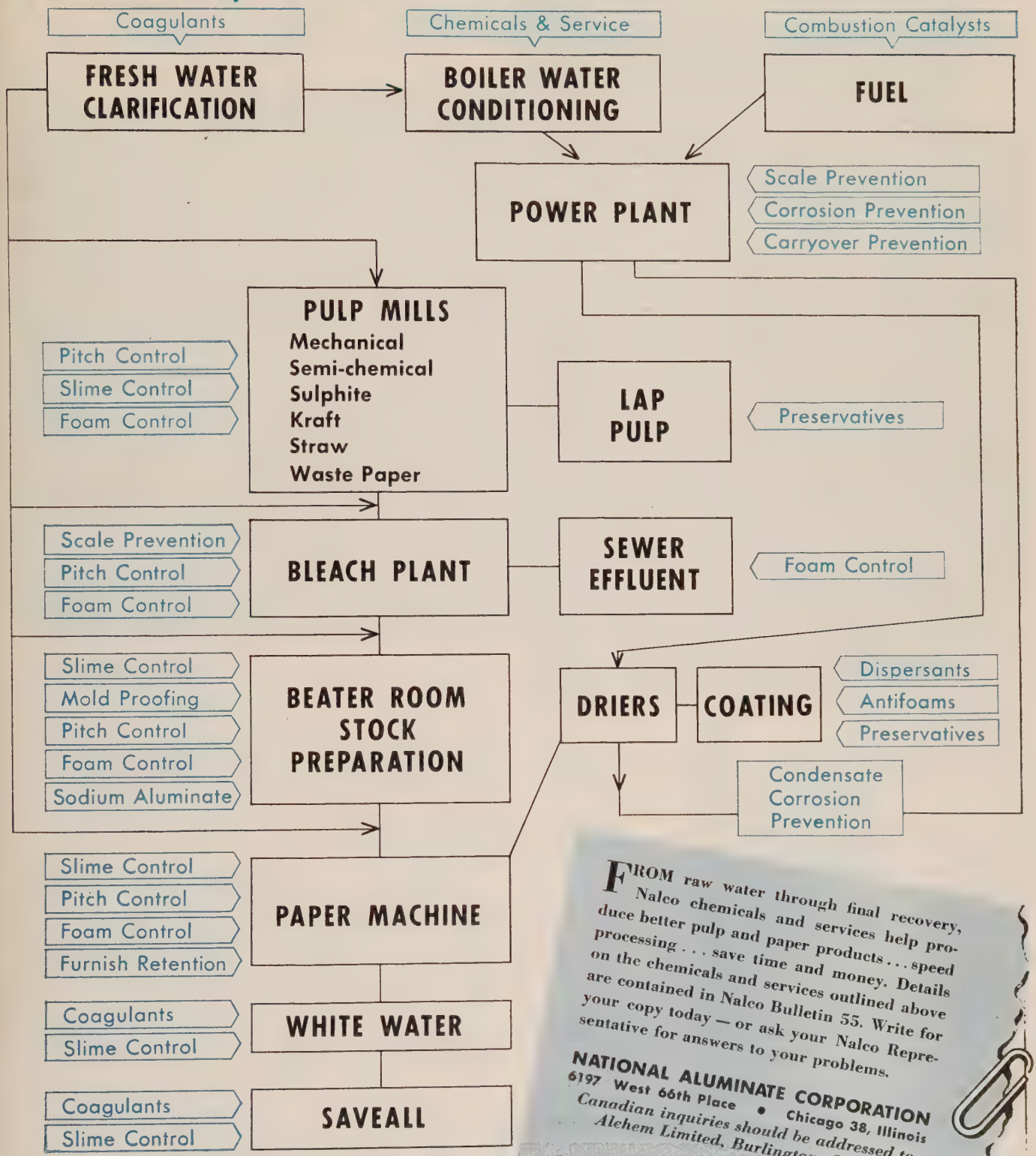

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For the fun of it, examine your sample swatches of these lines. You'll find that almost every color in each swatch is light in shade. Not necessarily pastel tints, though some are; but certainly not real-deep shades. Of course, a few grades do show dark browns, terra-cotta reds, and blues that are deep, but not many.

We have differentiated between the imitation leather cover—the pyroxylin-coated, soilproof, moistureproof, hardy type of cover paper—and the ordinary leather embossed antique cover paper to expand more effectively the point that the factors of color and finish, properly associated, can pay off for the paper buyer. This technique can only help to underscore the characteristics individual papers offer for specific end usage.

Selecting Colors

Actually, we could continue to cite chapter and verse until those legendary cows come home. But we can be more helpful by referring you to these detailed summaries of the color and finish factors. They're very much worth your studying, line by line.

Associating colors with groups of papers or surfaces of papers makes selection easy. For instance, certain grades of paper follow set color patterns:

50% and 25% Rag Content Bond Papers are made in white and six or seven pastel shades; some grades include goldenrod.

Sulphite Bond Papers like *Hammermill Bond, Howard Bond, Atlantic Bond, Hamilton Bond,* etc. show 13 or 14 colors—standard pastel tints, deep shades like russet and gray, and bright colors like salmon and goldenrod.

Number 2 Sulphite Bond Papers like *Maxwell Bond, Volume Bond, Management Bond* usually show a color range of only five or six pastel tints and goldenrod.

Text and Companion Cover Papers like Strathmore *Beau Brilliant,* Hamilton *Andorra,* Curtis *Tweedweave* feature strong, deep shades—maroons, terra cottas, burnt yellow and golds, purples, gray-blues and purple blues, strong yellow-greens, etc.

Text and Companion Cover Papers like Strathmore *Chroma,* Strathmore *Text,* and Strathmore *Pastelle,* Hamilton's *Gainsborough* and *Kilmory,* etc., show tints.

Simulated Leather cover papers always show deep colors.

Leather Embossed covers show the standard colors and light tints.

Colored Coated Blanks like Falpaco *Railroad* show bright colors.

Colored Toughcheck also features bright colors.

Developing a working file of papers cross-referenced for color classifications as indicated above is "must" activity for buyers or specifiers of paper.

The following check list of grades and color ranges should be helpful in the preparation of a library of paper information:

Grade	*Color range*
Rag bond	Standard pastel colors, goldenrod
Sulphite bond no. 1	Standard colors, deep colors, goldenrod
Sulphite bond no. 2	Standard colors, goldenrod
Sulphite bond no. 4	Standard colors, goldenrod
Coated-1-side bond	White, pastel colors, and goldenrod
Cover	
Antique	White, pastel, deep colors
Plate	White, pastel, deep colors
Embossed	White, pastel, deep colors
Simulated leather	White and deep colors
Coated	White, pastel, deep colors
Novelty[a]	White, pastel, deep, and bright colors
Rag ledger, ex. 100%	White, blue, buff
Rag ledger, 100%	White, buff
Rag ledger, 75%	White, buff
Rag ledger, 50%[b]	White, buff, green tint
Rag ledger, 25%[b]	White, buff, green tint
Sulphite ledger no. 1	White, buff, green tint
Sulphite ledger no. 2	White, buff
Sulphite ledger no. 4	White, buff, green tint
Rag index, 100%	White, blue, buff, canary, ecru, fawn, green, salmon
Rag index, 50%	White, blue, buff, canary, ecru, fawn, green, salmon
Rag index, 25%	White, blue, buff, canary, ecru, fawn, green, salmon
Sulphite index no. 1	White, blue, buff, canary, cherry, ecru, green, salmon
Sulphite index no. 2	White, blue, buff, canary, cherry, ecru, green, salmon
Sulphite index no. 4	White, blue, buff, canary, cherry, ecru, green, salmon
Vellum	White, pastel, deep colors
Printing bristol	
Antique	White, pastel, deep colors
Plate	White, pastel, deep colors
Coated	White, pastel, deep colors
Duplex	White, pastel, deep colors
Wedding bristol	White, pastel, deep colors
Folding bristol	White, deep colors, black
Duplex bristol	
Antique	Pastel colors on white
Coated	Deep colors on light colors
Tag	White, manila
Coated blanks	White
Coated R.R. blanks	Deep colors and black
Book	
Coated	White, pastel, and deep colors
English finish	White, pastel, and deep colors
Super	White, pastel, and deep colors
Litho coated	White, pastel, deep colors
Antique	White, india
Text	White, pastel, deep colors

[a] Like Crystallon, Dura-Glo, and Plasticolor.

[b] Mechano Form and Crest Ledger are available in a wider range of colors.

Colors in various text papers are distinctive; seldom do any two lines of text papers show identical colors.

Selecting Finish (Surface of Paper)

Every paper surface is functional and should be selected to serve the best possible purpose. For instance:

Seasoned buyers of papers for letterheads know better than to send highly cockled rag bond paper to a lithographer. The lithographer, for technical reasons, prefers flat-finished bond papers.

Seasoned printers of halftone illustrations on English finish papers wouldn't think of using screens finer than 120 or 100 line. The surface of the paper won't permit good reproductions of finer-screen plates. When groundwood English finish papers are used, 85 screen halftones are recommended.

Seasoned buyers of printing know that antique cover papers like *Daily Sales, Colophon,* and *Sulgrave,* to name a few, are smooth and velvety to the touch and perfect backgrounds for fine typography and fine-line engravings.

They also know that rough antique cover papers like Riegel's *Jersey, Strathmore,* and *Buckeye* are especially suitable when type and line plates are bold and postery.

Seasoned buyers of lithography know better than to try to lithograph on English finish book paper unless it has been especially hard-sized.

When users of fine text papers think in terms of laid and/or wove finishes, they almost automatically select from papers like *Ticonderoga Text, Kilmory, Strathmore Text, Beckett Text.*

When an especially rough-textured, felt-finished surface is needed in a cover or text paper, seasoned buyers look to their files of Hamilton's *Andorra,* Strathmore's *Beau Brilliant,* and similar papers.

These illustrations serve to emphasize the importance of finish-by-finish identification of all papers in everyday use.

A complete check list follows:

Finish	*Production data*
	Rag Bond
Full cockle	For printing line engravings and type, thermography, steel-die engravings, and intaglio
Medium cockle	For printing line engravings and type, thermography, steel-die engravings, and intaglio

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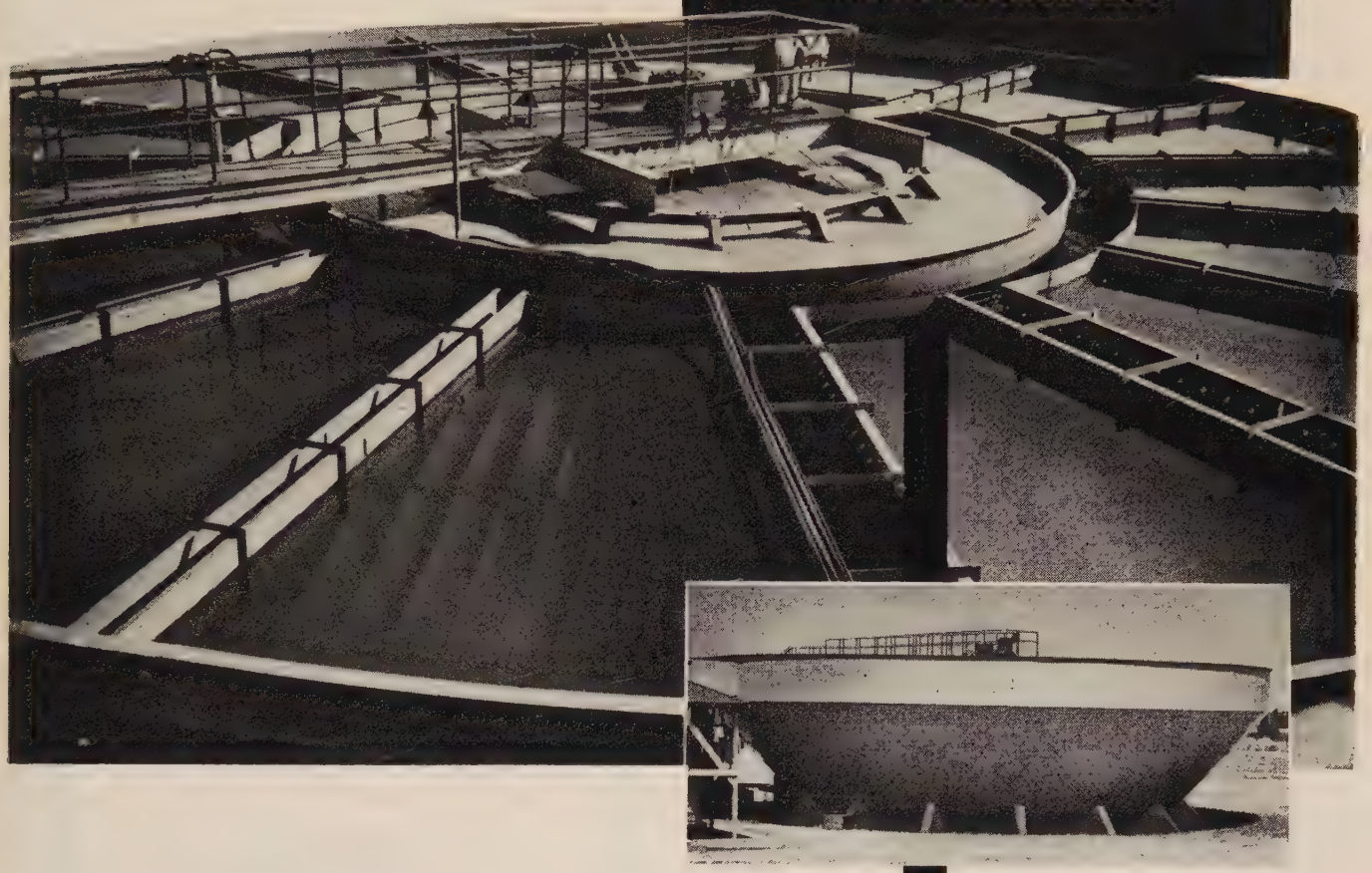

PROCESS WATER of highest quality (low color, iron and alkalinity) was the requirement of this paper mill . . . regardless of changes in raw water. In addition, space and installed cost were important considerations.

On all of these counts — uniform effluent quality, installed cost, and space savings — the Accelator secured the job, just as it has on many other installations. (Accelators are treating more than *one billion* gallons per day!)

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Finish	Production data
Flat	For lithographing, for printing line engravings and type, thermography, steel-die engravings, and intaglio
Sulphite Bond	
Smooth wove	For printing line engravings and type, lithographing, thermography, steel-die engravings, and intaglio
Bristol	
Antique vellum	For printing line engravings and type, lithographing, thermography, steel-die engravings, and intaglio
Plate	For printing up to 120-screen halftones, line engravings and type, for lithographing, thermography, steel-die engraving, and intaglio
Coated	For printing up to 133-screen halftones, line engravings, and type
Coated offset	For lithographing, for gloss ink letterpress printing, overprint, and spirit varnishing
Offset	
Regular wove,[a] and vellum	For lithographing, for printing line engravings and type, and gravure
Pigmented	For lithographing, for printing 120-screen halftones, line engravings, and type
Super	For lithographing, for printing up to 120-screen halftones, line engravings, and type
Machine finish	For lithographing, for printing up to 100-screen halftones, line engravings, and type
Coated	For lithographing, for gloss ink letterpress printing, overprint and spirit varnishing
Embossed patterns	For lithographing, for printing line engravings and type
Litho coated	For lithographing, for printing up to 133-screen halftones, line engravings, and type. (Varnish quality litho grades are recommended for gloss ink letterpress printing, overprint, and spirit varnishing)
Litho M.F. (hard-sized M.F.)	For lithographing, for printing line engravings and type
Litho super (hard-sized)	For lithographing, for printing line engravings and type
Cover	
Antique	For printing line engravings and type, for lithographing, for die-stamping, and embossing
Plate	For printing up to 120-screen halftones, line engravings and type, for lithographing, for die-stamping, and embossing
Embossed patterns[b]	For printing line engravings and type, for lithographing, for die-stamping and embossing
Simulated leather[c]	For printing line engravings and type, for die-stamping and embossing
Coated	For printing up to 133-screen halftones, line engravings and type, for embossing. (Some grades are recommended for gloss inks and spirit varnishing)
Coated offset	For lithographing, for gloss ink letterpress printing, overprint and spirit varnishing; for embossing
Text	
Antique wove, and laid	For printing line engravings and type, for lithographing, for virkotyping, for steel-die engraving, and gravure
Plate wove	For printing up to 120-screen halftones, line engravings, and type, lithographing, for virkotyping, for steel-die engravings, and gravure
Felt finish[d]	For printing line engravings and type, for lithographing, for virkotyping, for steel-die engraving, and gravure.
Double-coated	For printing halftones up to 150-screen, for line engravings and type. Some grades for gloss ink letterpress printing, overprint, and spirit varnishing
Single-coated	For printing halftones up to 133-screen, for line engravings and type. Some grades for gloss ink letterpress printing or varnishing
Machine coated	For printing halftones up to 120-screen, for line engravings and type.[e] Some grades for gloss ink letterpress printing or varnishing
Super	For printing halftones up to 120-screen, for line engravings and type
English finish	For printing halftones up to 110-screen, for line engravings and type
Antique (eggshell) wove	For printing line engravings and type
Antique laid	For printing line engravings and type
Blank	
Single-coated	For printing up to 120-screen halftones, line engravings, and type
Double-coated	For printing up to 133-screen halftones, line engravings, and type, for gloss ink letterpress printing, overprint and spirit varnishing
Offset coated	For lithographing, for gloss ink letterpress printing, overprint and spirit varnishing
Lined	For printing up to 100-screen halftones, line engravings and type
Box Board	
Patent coated, newsback	For printing up to 100-screen halftones, line engravings and type. (Also available for lithography)
Clay coated folding boxboard, newsback	For printing up to 120-screen halftones, line engravings and type. (Also available for lithography)
Clay coated folding boxboard, manila back	For printing up to 120-screen halftones, line engravings and type. (Also available for lithography)

[a] Some printers indicate they use smooth-finished offset papers like *Maxwell Offset* for printing 120-screen letterpress halftones.
[b] Such as ripple, linen, leather, handmade, woodgrain, etc.
[c] Like *Marco, Marvelhide,* and *Marvelleather.*
[d] Papers like *Pastelle, Chroma, Tweedweave, Weycroft.*
[e] *Production Gloss,* for instance.

REGULAR SIZES AND WEIGHTS OF PRINTING PAPERS

For the convenience of printers and users of printing, up-to-date charts showing regular sizes, regular weights, and equivalent weights of printing papers are shown:

Coated Cover

Letterpress and offset

Size	*Standard 20 × 26—ream weights*			
20 × 26	50	60	80	100
Sizes	*Equivalent weights per 1000 sheets*			
20 × 26	100	120	160	200
23 × 35	155	186	248	310
26 × 40	200	240	320	400
35 × 46	310	392	496	620

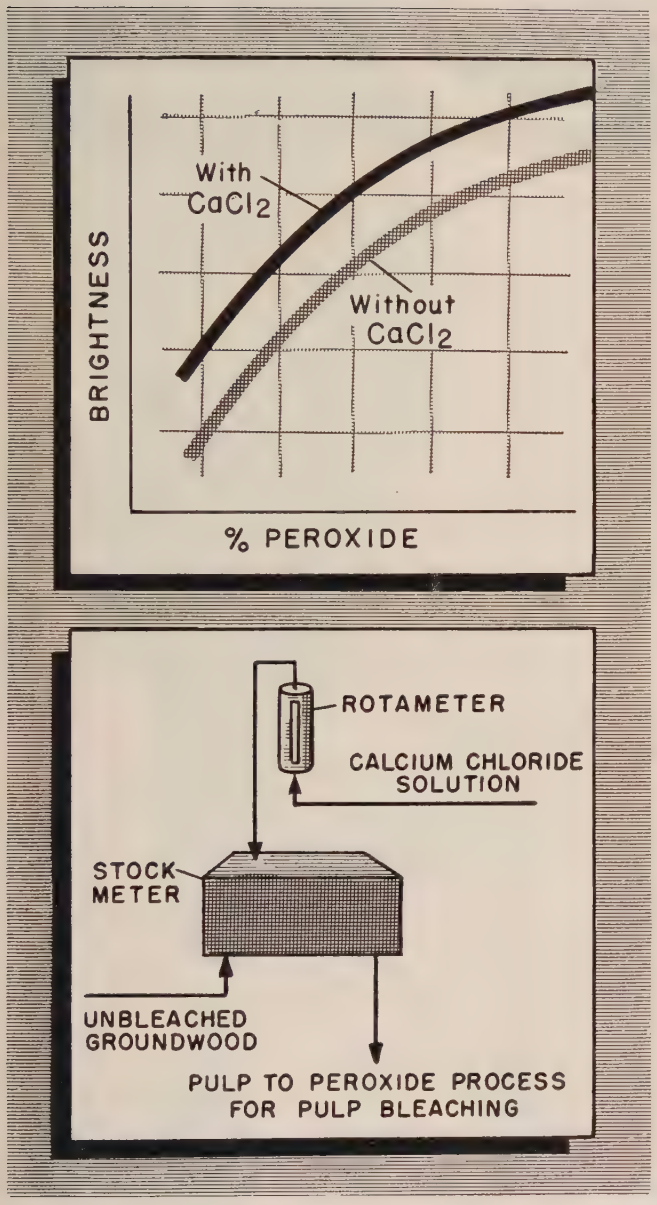
Uncoated Cover

Size	*Standard 20 × 26—ream weights*								
20 × 26	25	35	40	50	65	80	90	100	130
Sizes	*Equivalent weights per 1000 sheets*								
20 × 26	50	70	80	100	130	160	180	200	260
23 × 35	78	108	124	155	201	248	279	310	402
26 × 40	100	140	160	200	260	320	360	400	520

Printing Bristol

$22\frac{1}{2} \times 28\frac{1}{2}$	80	90	100	120	140	160	180	200	220
Sizes	*Equivalent weights per 1000 sheets*								
$22\frac{1}{2} \times 28\frac{1}{2}$	160	180	200	240	280	320	360	400	440
$22\frac{1}{2} \times 35$	...	...	250	300	350	400	...	...	...
26 × 40	...	...	330	396	...	...	...	...	...

Higher brightness for your pulp...



without increased peroxide consumption!

ANOTHER DU PONT CONTRIBUTION TO BETTER GROUNDWOOD BLEACHING

Here's an easy, economical way to get several points' increase in the brightness of groundwood. The process is a Du Pont development and involves pretreating the pulp with calcium chloride. It's designed for use in medium-consistency bleaching systems and is so simple to install that it can be put into operation within hours!

All that's needed is an ordinary dissolving tank and the assistance of Du Pont technical men. These men possess a know-how born of years of experience and are always available to the industry without cost or obligation. They'll be glad to show you how to install and operate this process improvement. Just send in the coupon below for details.

Mail this coupon for complete information

E. I. du Pont de Nemours & Co. (Inc.)
Electrochemicals Dept., T-103, Peroxygen Products Div.
Wilmington 98, Delaware

Please send me complete information about increasing groundwood brightness by pretreating with calcium chloride.

Name _____ *Position* _____

Firm _____

Address _____

City _____ *State* _____

DU PONT
PEROXIDES
FOR WOOD PULP BLEACHING

"Albone".....Hydrogen Peroxide
"Solozone"..... Sodium Peroxide

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Index Bristol

Size	Standard 25½ × 30½—ream weights			
25½ × 30½	90	110	140	170
Sizes	**Equivalent weights per 1000 sheets**			
20½ × 24¾	117	144	182	222
22½ × 28½	148	182	230	280
22½ × 35	182	222	284	...
25½ × 30½	180	220	280	340

Coated Bristol and Postcard

Letterpress and offset

Size	Standard thicknesses, in.			
22½ × 28½	0.008	0.010	0.011	0.012

Uncoated Book Paper

English Finish, supercalendered, antique

Size	Standard 25 × 38—ream weights						
25 × 38	30	35	40	45	50	60	70
Sizes	**Equivalent weights per 1000 sheets**						
22½ × 35	50	58	66	75	83	99	116
24 × 36	54	64	72	82	90	110	128
25 × 38	60	70	80	90	100	120	140
28 × 42	74	86	100	112	124	148	174
28 × 44	78	90	104	116	130	156	182
30½ × 41	78	92	106	118	132	158	184
32 × 44	88	104	118	134	148	178	208
33 × 44	92	106	122	138	152	184	214
35 × 45	100	116	132	150	166	198	232
36 × 48	110	128	146	164	182	218	254
38 × 50	120	140	160	180	200	240	280

Uncoated Offset

Size	Standard 25 × 38—ream weights						
25 × 38	50	60	70	80	100	120	150
Sizes	**Equivalent weights per 1000 sheets**						
17½ × 22½	41	50	58	66	83	99	...
22½ × 29	68	82	96	110	137	...	...
23 × 29	70	84	98	112	140	...	...
22½ × 35	83	99	116	133	166	199	...
25 × 38	100	120	140	160	200	240	300
28 × 42	124	148	174	198	248	298	...
28 × 44	130	156	182	208	260	312	...
32 × 44	148	178	208	238	296	356	...
35 × 45	166	198	232	266	332	398	...
36 × 48	180	218	254	292	364	436	...
38 × 50	200	240	280	320	400	480	600
38 × 52	208	250	292	332	416	500	...
41 × 54	234	280	326	372	466	560	...
42 × 58	256	308	358	410	...	...	...
44 × 64	296	356	416	476	592	712	...

Coated Two Sides Book Paper

Letterpress and offset

Size	Standard 25 × 38—ream weights							
25 × 38	50[a]	55[a]	60	70	80	90[b]	100	120
Sizes	**Equivalent weights per 1000 sheets**							
17½ × 22½[c]	...	...	...	58	66	74½	83	99
19 × 25	50	55	60	70	80	90	100	120
23 × 29[c]	...	...	...	98	112	126	140	169
22½ × 35	83	91	99	116	133	149	166	199
24 × 36	90	100	110	128	146	164	182	208
25 × 38	100	110	120	140	160	180	200	240
26 × 40	110	120	132	154	176	198	218	262
28 × 42	124	136	148	174	198	222	248	298
28 × 44	130	142	156	182	208	234	260	312
32 × 44	148	164	178	208	238	266	296	356
35 × 45	166	182	198	232	266	298	332	398
36 × 48	182	200	218	254	292	328	364	436
38 × 50	200	220	240	280	320	360	400	480
41 × 54	...	...	...	326	372	...	466	560

[a] Machine coated only.
[b] Letterpress only.
[c] Not standard in machine coated papers.

Coated One Side Label Paper

Letterpress and offset

Size	Standard 25 × 38—ream weights		
25 × 38	50[a]	60	70
Sizes	**Equivalent weights per 1000 sheets**		
20 × 26	55	66	79
25 × 38	100	120	140
26 × 40	110	132	154
28 × 42	124	148	174
28 × 44	130	156	182
32 × 44	148	178	208
35 × 45	166	198	232
36 × 48	182	220	256
38 × 50	200	240	280
41 × 54	234	280	326

[a] Machine coated.

Bond, Ledger, Mimeograph, Duplicator, Vellum

Size	Standard 17 × 22—ream weights							
17 × 22	13	16	20	24	28	32	36	40	44
Standard sizes of bonds, writings, and mimeograph									
17 × 22		17 × 28		19 × 24		22 × 34			
22½ × 35		24 × 38		28 × 34		34 × 44			
Standard sizes for ledgers									
16 × 21	17 × 28	18 × 46	19 × 48	21 × 32	23 × 36	28 × 34			
17 × 22	18 × 23	19 × 24	20 × 28	22 × 34	24 × 38	....			

For *friendly* technical help on chemical problems, call on HOOKER

If you are planning or building a new mill, your Hooker technical service man can help you:

- arrive at chemical requirements
- determine how chlorine and caustic soda will be handled
- select equipment and check plant construction
- test chlorine lines
- make preliminary batch of bleach liquor
- start evaporators and other equipment

On a mill already in operation, your Hooker man can serve you by:

- checking quality and quantity of chemical shipments on arrival
- offering helpful advice when you are changing a process
- developing safety programs, in cooperation with your engineering department, plant employees, and local authorities
- providing helpful tips on bleach liquor making, reducing sludge losses, pulp washing
- assisting on color reversion problems

Behind Hooker technical service is a record of nearly 50 years in supplying your industry with chlorine, caustic soda, and other chemicals of uniform dependable quality.

Call us now - **Let us serve you often.**

New 76-Page Manual

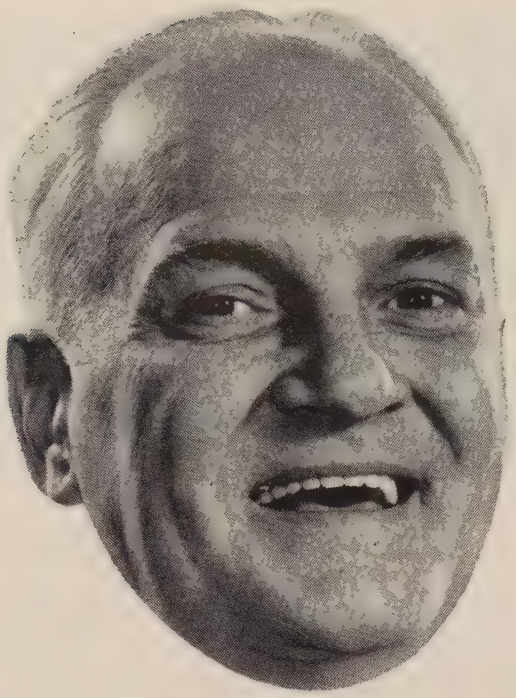
Describes pulp chlorination, production of lime bleach, preparation of soda bleach, analysis of hypochlorite solutions, equipment and methods for handling chlorine, and Hooker services available. For your free copy, write on your business letterhead to Hooker Electrochemical Company, 4704 Buffalo Avenue, Niagara Falls, N. Y.

From the Salt of the Earth

HOOKER ELECTROCHEMICAL COMPANY

NIAGARA FALLS • TACOMA • NEW YORK • CHICAGO • LOS ANGELES

HOOKER CHEMICALS



"It's proved 200% to 300% more efficient"

GLIDDEN PROSIZE

No matter what your present sizing practice may be, it will pay you well to have a representative of the Glidden Technical Service demonstrate all the advantages you can gain from using Prosize in your mill. After changing from conventional rosin size to Prosize, users have reported that . . .

- Prosize Process is 200 to 300% more efficient.
- Prosize Process produces a better, more stable size which gives paper uniform resistance to liquids of various types, such as ink, water, meat juices, etc.
- Prosize Process permits duplication of results from run to run on grades never before made because of sizing difficulties.
- Prosize Process minimizes seasonal variations—is highly effective on stocks heated by long beating or hard jordaning.
- Prosize Process permits sizing at a higher or more neutral pH.
- Prosize Process requires from 35 to 65% less rosin size and from 15 to 30% less alum, making it generally *less expensive* to use.

Prominent mills with a combined production of thousands of tons of paper a day have proved this patented Glidden Prosize Process, utilizing Glidden Alpha* Protein in combination with rosin size and boric acid, to be a superior means of sizing.

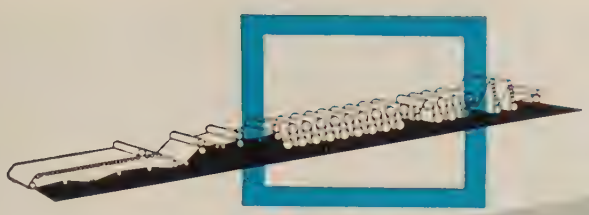
** Trademark Registered*

QUALITY Glidden PRODUCTS

THE GLIDDEN COMPANY

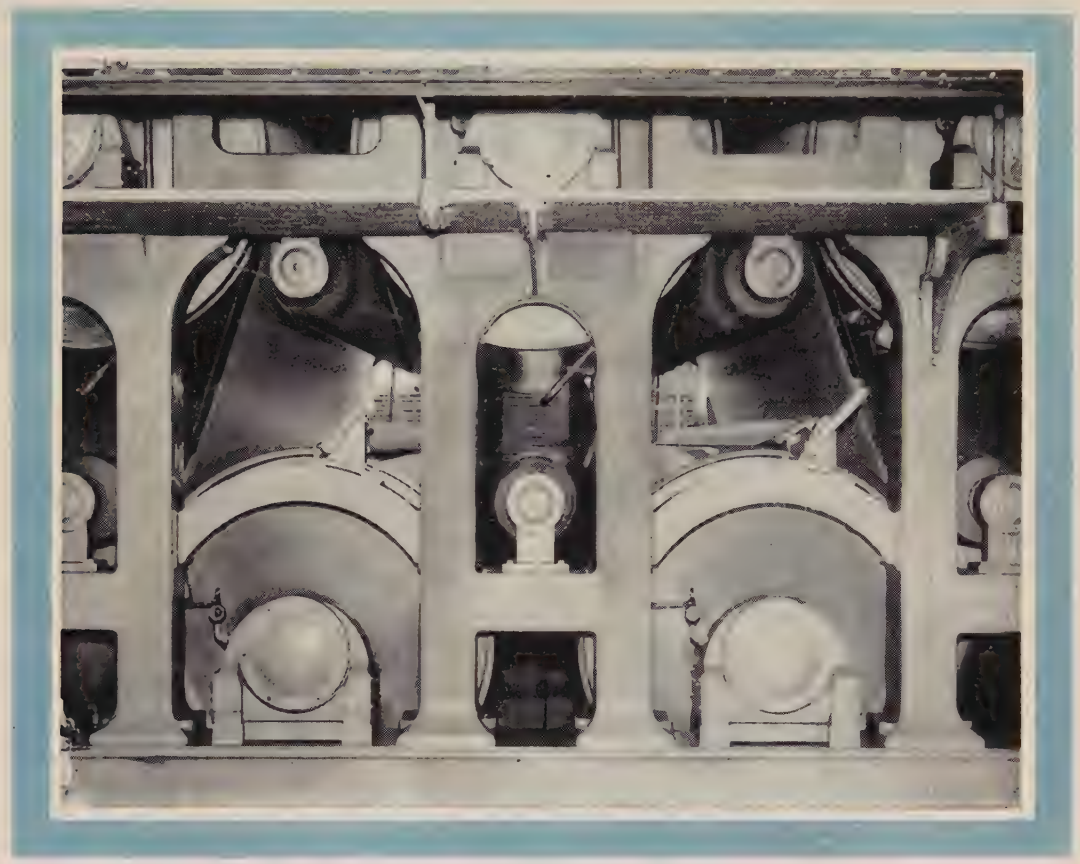
SOYA PRODUCTS DIVISION

1825 N. Laramie Avenue • Chicago 39, Illinois



For Peak Dryer Efficiency . . .

- - a Rice Barton Dryer Section



Rice Barton's unique spacing of dryers, which provides more evaporation space within a given length in the dryer section, increases drying rates without affecting steam consumption.

— and of course . . .

Shop erected and aligned dryer sills, frames and bearings, which eliminate costly drilling in the field, balanced dryers, and hobbed and generated-tooth dryer gears are among the many standard features which make a Rice Barton dryer section superior.

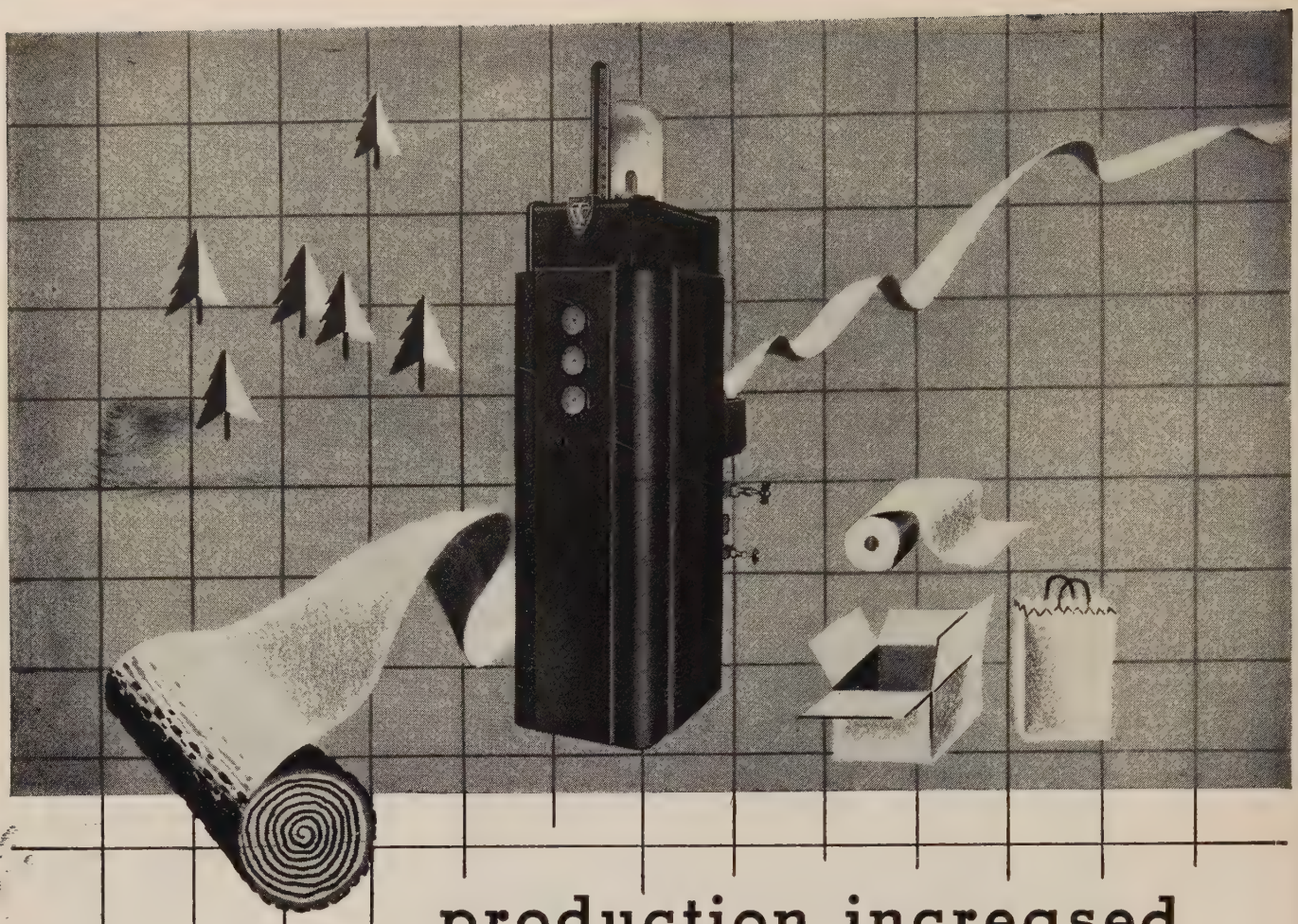
RB10-53

RICE BARTON CORPORATION

Worcester, Massachusetts

Paper Machine Builders Since 1837

West Coast Distributor: **Ray Smythe** • • 501 Park Building • Portland, Oregon



production increased up to 15 tons per day...

. . . with W & T chlorination equipment

A Southern mill had been having trouble with paper breaks attributable to the presence of slime in their white water. Despite continued efforts to control them slime breaks were running 60 to 80 per week, resulting in a time loss of 10 to 14 hours per week, and an average production loss of 15 tons per day! It was then that the W&T man was called in. Where and how to apply the proper treatment was determined, the costly methods were discontinued, and W&T chlorination was installed.

During the first 3 days of chlorination the mill recorded only 1 slime break and 2 minutes of lost time.

During the next 3 days there were 4 breaks and 17 minutes of lost time.

During the next 25 days there were no breaks attributable to slime!

. . . Within a week there were no production losses caused by slime! Performance such as that is typical of what your W&T representative can do for you.

If you have a production problem attributable to impure water, it would pay you to write or call him now.

WALLACE & TIERNAN
COMPANY, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
NEWARK 1, NEW JERSEY • REPRESENTED IN PRINCIPAL CITIES

I-42

WAX PROTECTION that leads to PROFITS

NOPCO*

WAX SIZES

Although they have no problems of cost-cutting and selling, bees employ the best wax they can obtain to protect their product.

How much more important for you to do likewise, if you produce sized papers and boards that must meet competition and yet be produced economically enough to help you make a profit?

It's a situation that calls for your careful consideration of Nopco Wax Sizes—the sizes which have been expressly developed to meet the needs of the paper, paper board, and fiber board manufacturer. With Nopco Wax Sizes, you can give your products exactly the protective properties you seek to impart. In fact, you obtain just the results you desire—with gratifying *economy*.

And remember, Nopco distribution is nationwide, and our technical representatives—convinced that helping you sell *your* products is the surest way of selling *ours*—will gladly work closely with you . . . in your own mill, if you wish.

We particularly refer you to—

NOPCO'S NEW ACID-STABLE SIZE:

Nopco 2252-A—a widely-accepted surface and beater size which resists acid, alum, and alkali. Uniformity guarantees superb performance.

NOPCO'S ALUM-SENSITIVE SIZES:

Nopco 2252—the ready-to-use, liquid paraffin wax size (with particle size less than ½-micron) that is ideal for waterproofing insulating board, butchers' wrap, and other internally sized grades.

Nopco 2251-X—the anhydrous size that saves freight and is extremely easy to use. A perfectly balanced wax and emulsifier.

Nopco 2251 and Nopco 2251-B—anhydrous, freight-saving, wax emulsifiers that will carry the highest amount of paraffin wax consistent with good emulsion stability. Particle size less than ½-micron, and quick alum sensitivity assure complete retention by fiber.

LOOK TO NOPCO ALSO AS YOUR SOURCE OF SUPPLY FOR:

Foam Killers • Sulfated Oils • Emulsified Resins • Coating Compounds • Wax Emulsions and Emulsifiers • Rewetting Agents • Insoluble Metallic Soap Dispersions • Sheet Formation Aids • Plasticizers • High Free Rosin Sizes Pitch Dispersants.

NOPCO EVOLVED THRU RESEARCH

NOPCO CHEMICAL COMPANY Harrison, N. J.

Branches: Boston • Chicago • Cedartown, Ga. • Richmond, Calif.

*Reg. U. S. Pat. Off.

Simpler Measurement of Flow and Level ...even on "Problem" Fluids

Corrosive or viscous pulp and paper making fluids that always have caused difficulties in measuring can now be accurately and easily metered with the Foxboro d/p Cell. More than 25,000 installations of this unique all-metal flow transmitter for these and other industrial fluids indicate its wide acceptance and successful performance.

Simpler, less expensive to install and maintain, the d/p Cell offers trouble-free flow and level measurement of "problem fluids" as well as of water, steam, or air . . . transmits pneumatically or electronically to indicating, recording, or controlling receivers. Small, compact, mercury-less and floatless, the d/p Cell weighs less than 19 lbs. Its negligible displacement and corrosion-proof construction eliminate usual maintenance problems.
Ranges: from 25" to 800" water.
Working pressures to 4000 psi.
Steel or Type 316 Stainless construction, or other materials as required.

Let us show you how the d/p Cell can help you to better measurement and control. Write today, or ask your Foxboro Field Engineer.

Fluids like these are "naturals" for d/p Cells

thin black liquor
thick black liquor
semi-chemical cooking liquor
white liquor
red liquor
green liquor
cooking acid
chlorine
caustic
hypo
chlorine dioxide
sulphuric acid
sodium chlorate
methanol
water
steam
air
stock, up to 4%

THE FOXBORO COMPANY, 977 NEPONSET AVE., FOXBORO, MASS., U.S.A.

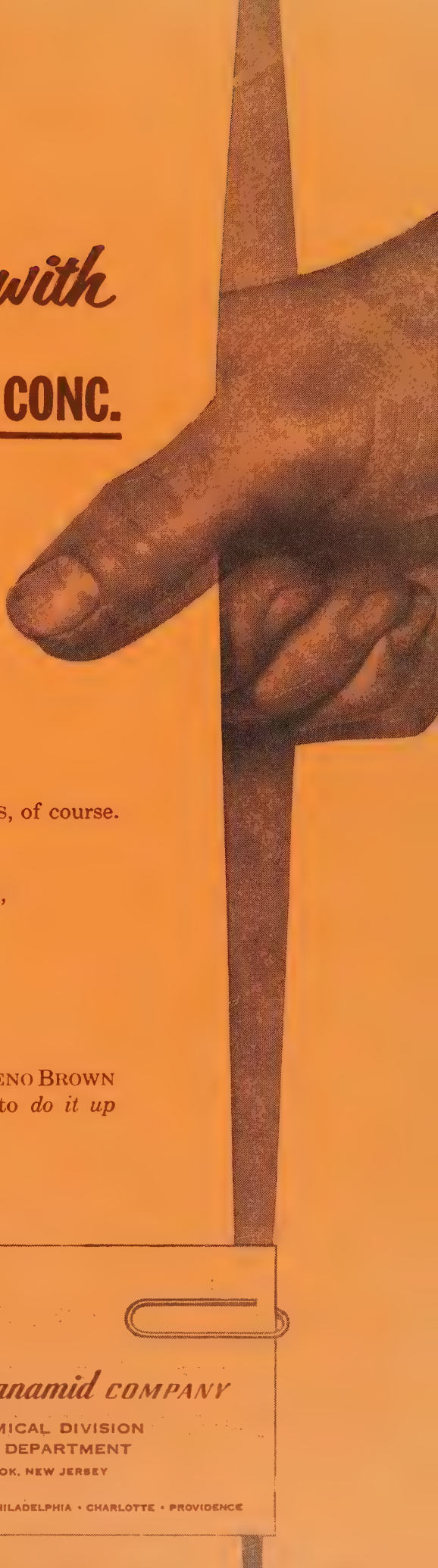
FOXBORO REG. U.S. PAT. OFF. d/p cell

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

let's do it up Brown with

PHENO BROWN 3GXX SUPER CONC.

DUSTLESS



What . . .
Bag, tissue, wrapping, board and specialty papers.

How . . .
With PHENO BROWN 3GXX SUPER CONC., DUSTLESS, of course.

Where . . .
In the beaters, hydropulpers, mixing chests and tanks, fan pumps and head box.

Why . . .
To obtain a variety of shades from rich deep brown to conservative pastel tints.

Its economy and excellent working properties make PHENO BROWN 3GXX SUPER CONC. DUSTLESS an excellent choice to *do it up brown.*

SEE REVERSE SIDE for a listing of Calco's many efficient colors for paper.

NORTH AMERICAN CYANAMID LIMITED
CALCO CHEMICAL DIVISION
MONTREAL—TORONTO

Calco®

AMERICAN Cyanamid COMPANY
CALCO CHEMICAL DIVISION
DYESTUFF DEPARTMENT
BOUND BROOK, NEW JERSEY

NEW YORK • CHICAGO • BOSTON • PHILADELPHIA • CHARLOTTE • PROVIDENCE

COLORS FOR PAPER

organic

dyes	Acid Basic Direct Spirit Sulfur Vat	pigments	Calcotone* Pastes Lakes and Pulps Helmerco* (Molybdate & Tungstate Lakes)

inorganic pigments

natural	Burnt Sienna Raw Sienna Burnt Umber Raw Umber Ochres	manufactured	Blacks—Mineral & Paris Coating Pulps Chrome—Greens, Oranges & Yellows Calcotone Pastes Molybdate Oranges Red Iron Oxides Ultramarine Blues (Dry and Pulp) Unitane® (Titanium Dioxide, Anatase and Rutile)

miscellaneous & specialties

Calcofluor* Whites (Whitening Agents)
Calcotone* (Pigment Dispersions)
Dybrytes (Bleed Fast Alcohol & Water Soluble Dyes)
Sap Brown—Crystal and Powder Dark Brown S
Soluble American Blue (Soluble Iron Blue)
Spirit Dybryte* (Bleed Fast Spirit Soluble Dyes)

*Trade-mark

Calco®

AMERICAN Cyanamid COMPANY

CALCO CHEMICAL DIVISION
DYESTUFF DEPARTMENT
BOUND BROOK, NEW JERSEY

80 years until harvest time

Douglas fir forests, which supply raw material for most of Weyerhaeuser's mill sites, require 80 years to grow a seedling into a tree of mature size. Contrary to popular belief, only a small part of the total program of reforestation is accomplished by artificial planting and seeding. The primary reforestation job is the restocking of cut over land as old growth timber is harvested. This is being done by natural reforestation with seed supplied from blocks of trees reserved during logging and left standing to reseed the adjacent cut-over area. Where natural seed sources have failed, artificial reforestation by sowing tree seeds with helicopters or mechanical seeders is used.

As more and more virgin timber stands are logged in the forests under Weyerhaeuser management, the harvested land begins growing new trees. As the supply of mature timber diminishes, it will be replaced by a steadily increasing volume of new growth.

There are good possibilities of increasing the yield from this land through silvaculture research and intensified forestry and harvesting practices. Thus Weyerhaeuser's twin goals are a *sustained* and *increased* yield of cellulose products from its 2,500,000 acres of timber land.

PULP DIVISION WEYERHAEUSER

Sulphur

Molten Sulphur flowing into the storage vat

Thousands of tons mined daily, but where does it all go?

Look around you in any grocery store and what do you see — canned goods of all kinds! Soups, vegetables, fruits, berries! Believe it or not, you're looking at merchandise that consumed a lot of Sulphur in the making.

Tin cans are made of tin plate. Tin plate is made of sheet steel. Sheet steel is made with the help of sulphuric acid—pickling, as they call it, the process that removes scale preparatory to plating. In 1951, the sheet division of our great iron and steel industry is estimated to have consumed 140,000 long tons of Sulphur in the form of sulphuric acid. That in itself makes quite a dent in our supplies of Sulphur. Add to this almost as much more for treating wire rod, plate, strip, bars, etc., and you can see that to make finished steel, regardless of form, the iron and steel industry must use lots of Sulphur in the form of sulphuric acid.

Right here is an excellent example of the interdependence of all of our industries. To produce steel requires a lot of Sulphur. To produce Sulphur and other mined products requires a lot of steel. This interdependence of industries is one of the country's sources of strength.

Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N. Y.

Mines: Newgulf and Moss Bluff, Texas

MOST FURNISHES GET HIGHER WET-STRENGTH FASTER FROM

UFORMITE 700

UFORMITE 700 gives you fast wet-strength on almost any type of job—bag stock, toweling, food wrap, blueprint, map paper, twisting tissue, or liner board. It's suitable for many other wet-strength uses, too—and for almost any furnish, whether it be groundwood, kraft, sulfite, or rag.

In wet-strength paper, UFORMITE 700 gives you these advantages:—

1. Fast wet-strength—*right off the machine*
2. High efficiency—*over a wide range of resin-to-pulp ratios*
3. Adaptability—*to almost any furnish*
4. Ease of mixing—*without acid, aging or special equipment*
5. Convenient pH control—*with acid, alum, or blends of acid and alum*
6. Wide flexibility—*in point of addition*

Write for your sample of UFORMITE 700 and for technical literature. For detailed recommendations, tell us about your special problem.

CHEMICALS FOR INDUSTRY

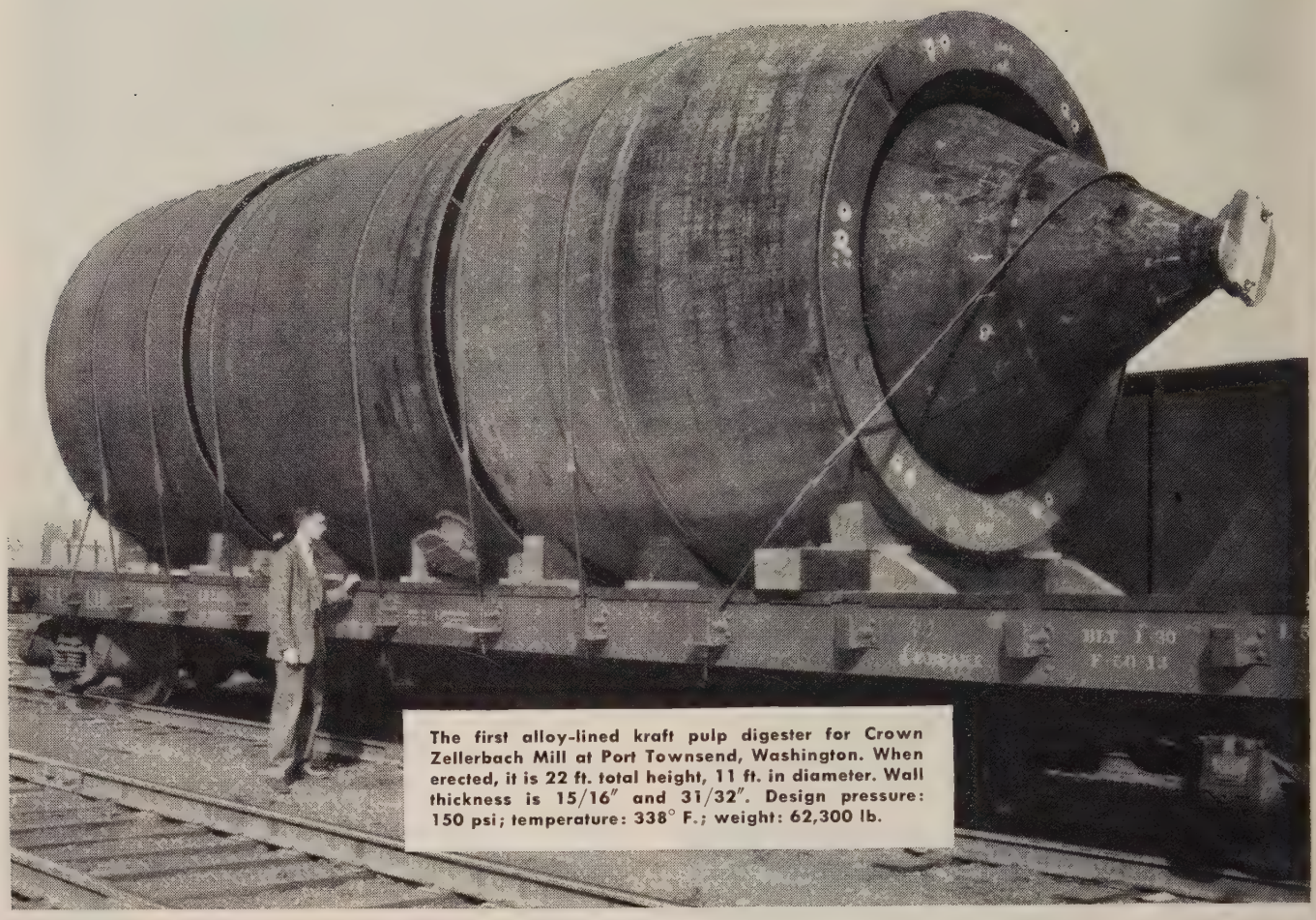
ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

Washington Square, Philadelphia 5, Pa.

Representatives in principal foreign countries

UFORMITE *is a trademark, Reg. U. S. Pat. Off. and in principal foreign countries.*



The first alloy-lined kraft pulp digester for Crown Zellerbach Mill at Port Townsend, Washington. When erected, it is 22 ft. total height, 11 ft. in diameter. Wall thickness is 15/16″ and 31/32″. Design pressure: 150 psi; temperature: 338° F.; weight: 62,300 lb.

The sulphate digester that A. O. Smith pre-testing prescribed

There was no experience data on corrosion resistant lining for kraft digesters before 1945, when Crown Zellerbach found it necessary to replace a line of digesters in their kraft mill after a change in pulping material was forced upon it.

A. O. Smith's wide experience in building alloy-lined pressure vessels for oil refineries was called upon to help solve the severe corrosion conditions that faced this mill.

An intensive laboratory and field test of stainless steels and carbon steel was conducted for two years. Samples were exposed to the corrosive liquors and vapors in digesters at the mill and then studied for determination of corrosive rates. Other samples were given accelerated corrosion tests in both white and black liquors imported by the A. O. Smith laboratories. Operating conditions were simulated and these tests conducted simultaneously with the field tests.

One of the alloys was proved superior by these tests and was selected as the lining material for digesters to be built in the A. O. Smith vessel shops. Seven digesters, like the one shown above, were built for the new line and each was shipped in three sections to facilitate installation at the mill.

A. O. Smith cooperated with the paper manufacturer not only in erecting and welding the sections together, but also in developing equipment for stress-relieving the welds and by instructing mill personnel in maintaining the lining and in evaluating corrosion rate of the vessel during periodic inspections.

Our research and engineering groups, backed by unparalleled accumulated data on corrosion resistance problems in the paper industry, are always available to assist you in the solving of any digester or other vessel problems. Inquiries receive prompt and expert handling.

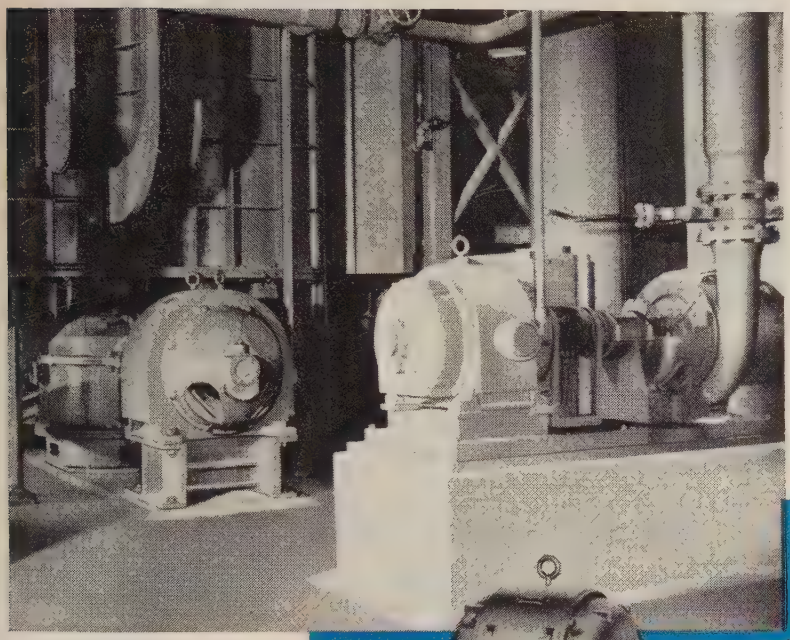
A.O.Smith
CORPORATION

PRESSURE VESSELS • HEAT EXCHANGERS

Chicago 4 • Cleveland 15 • Dallas 2 • Denver 2 • Houston 2
Los Angeles 22 • Midland 5, Texas • New Orleans 12
New York 17 • Pittsburgh 19 • San Francisco 4 • Seattle 1
International Division: Milwaukee 1

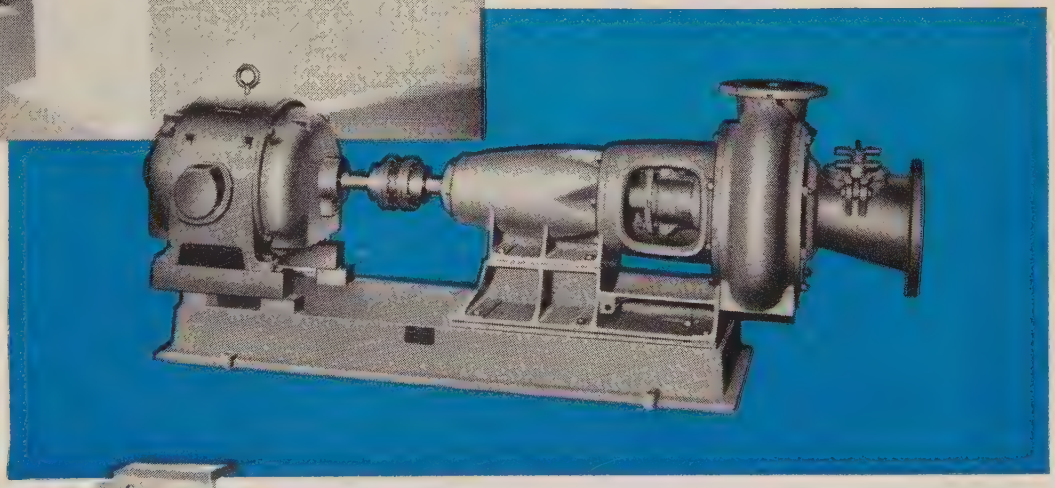
THE KEY TO SUCCESSFUL STOCK HANDLING

Downingtown-Economy Centrifugal Pumps

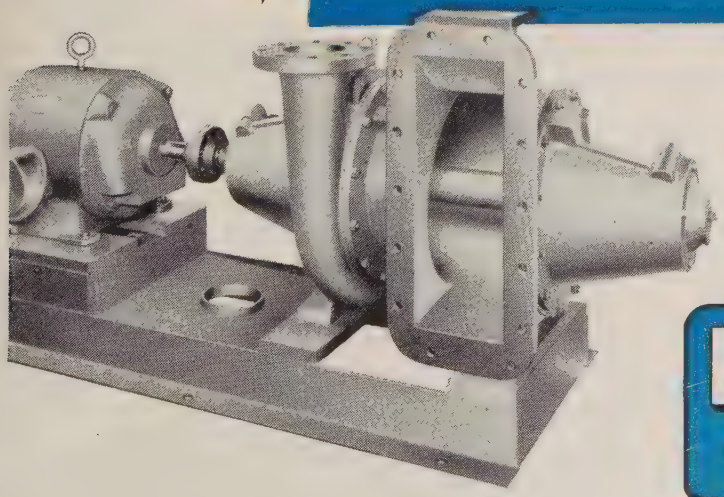


Designed and built expressly for the paper and board industries, Downingtown-Economy Pumps provide the most efficient and economical answers to the problems encountered in stock handling. Standard materials used are those best suited to normal mill operating conditions. Custom engineered pumps are furnished with special metals and for unusual service. All pumps are available in a wide selection of capacities.

Write for the new Downingtown-Economy Pump Bulletin, which gives complete selection tables.



DOWNINGTOWN-ECONOMY
Double Suction White Water Pumps
This group of pumps is designed to handle white water and general water supply.

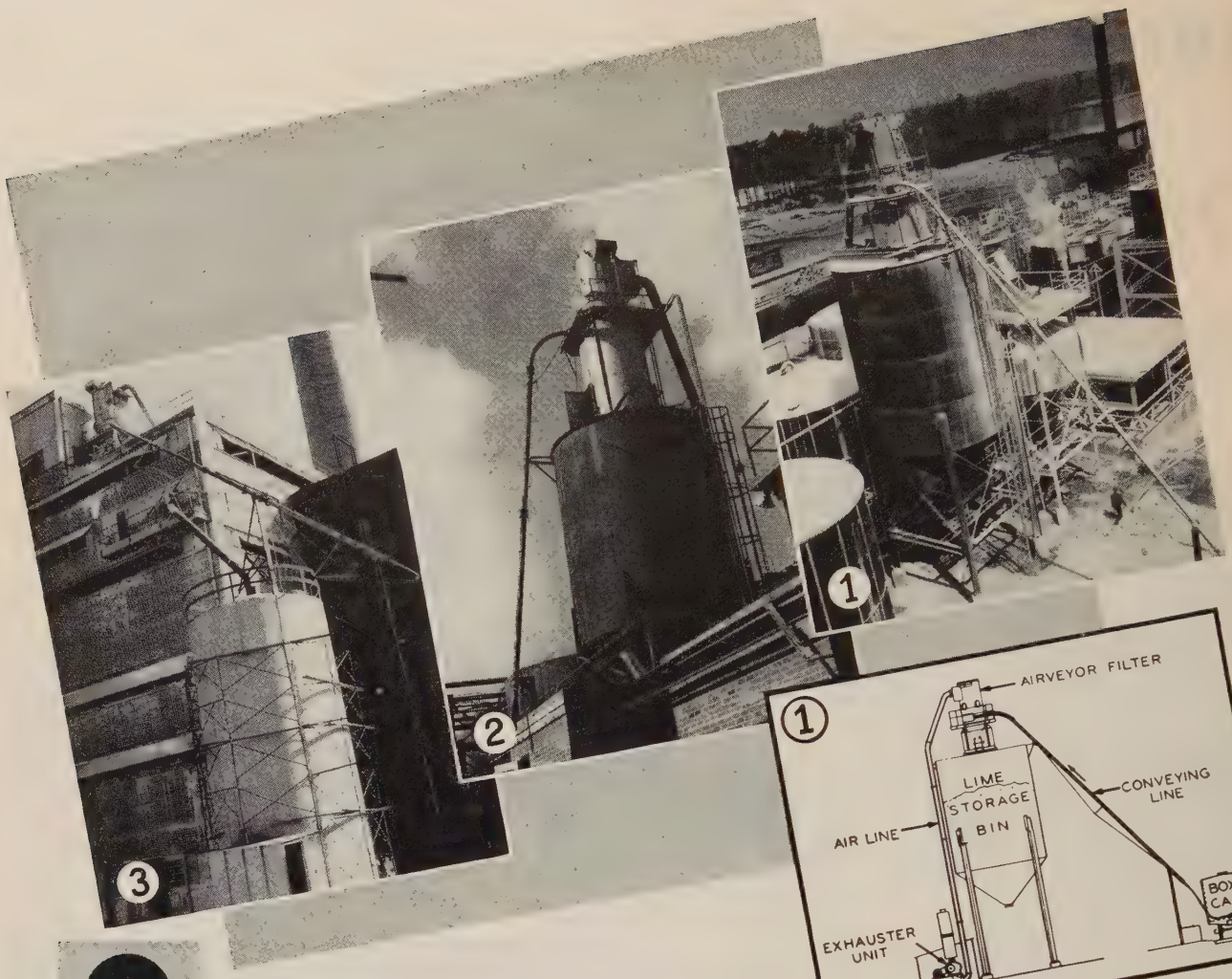


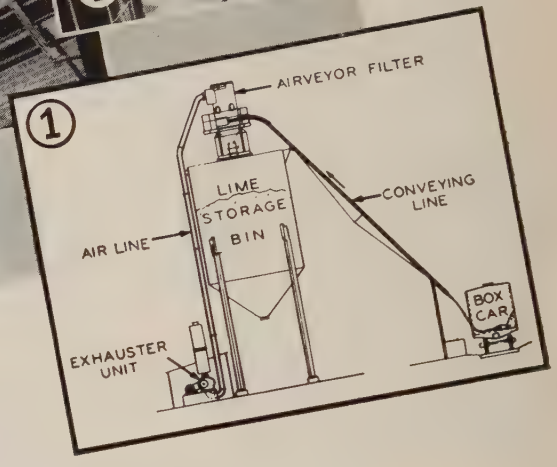
DOWNINGTOWN-ECONOMY
Single Suction HC* Stock Pumps
For high consistency stocks, these pumps are equipped with specially designed impellers. HC Stock Pumps are available in both vertical and horizontal models.*
*High consistency

DOWNINGTOWN MANUFACTURING CO.
DOWNINGTOWN, PA.

West Coast Representative:
John V. Roslund
Pacific Bldg.
Portland 1, Oregon.

DOWNINGTOWN
DESIGNERS AND BUILDERS OF PAPER, BOARD AND FELT MACHINES SINCE 1880
MODERNIZATION IS PROFITABLE





3 AIRVEYOR® SYSTEMS work for RIEGEL-CAROLINA

When the new 200-ton pulp mill of the Riegel-Carolina Corporation, Acme, North Carolina, was designed and built, they selected and installed Airveyors for handling mill-supply chemicals.

Fuller
CONVEYS BY AIR
...NOTHING MOVES BUT THE MATERIAL

A-165
1943

3 Airveyors are in use:

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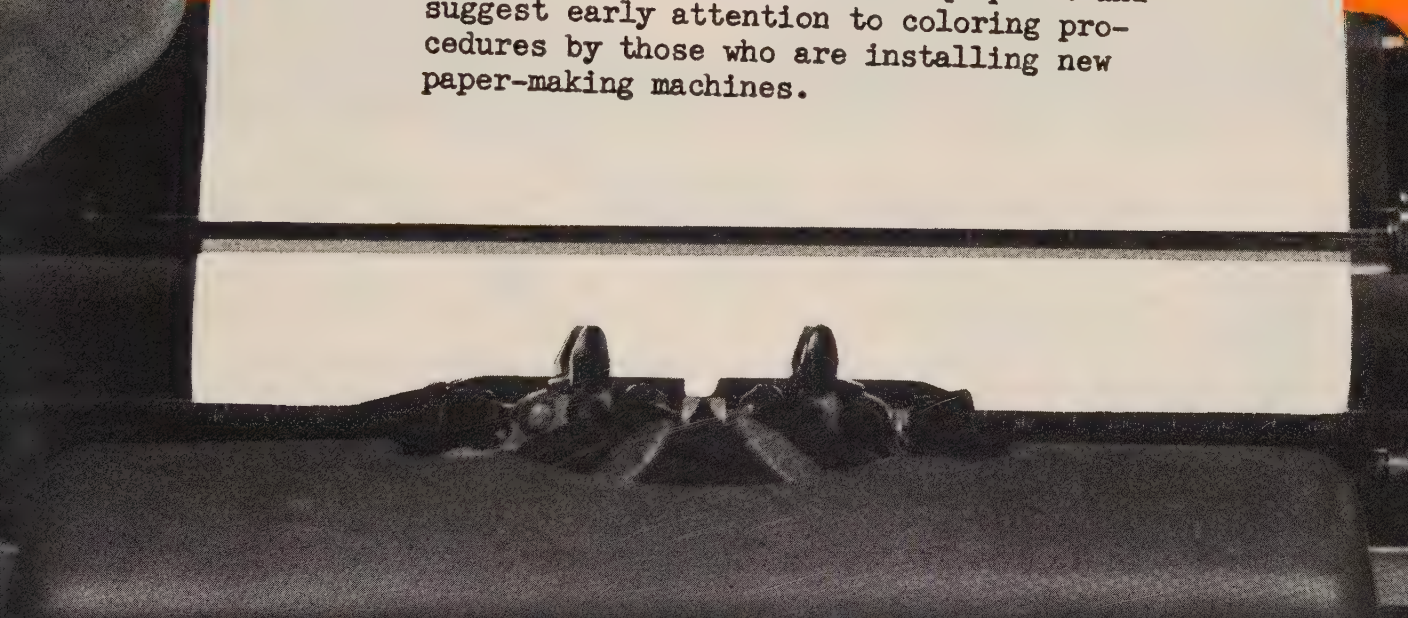

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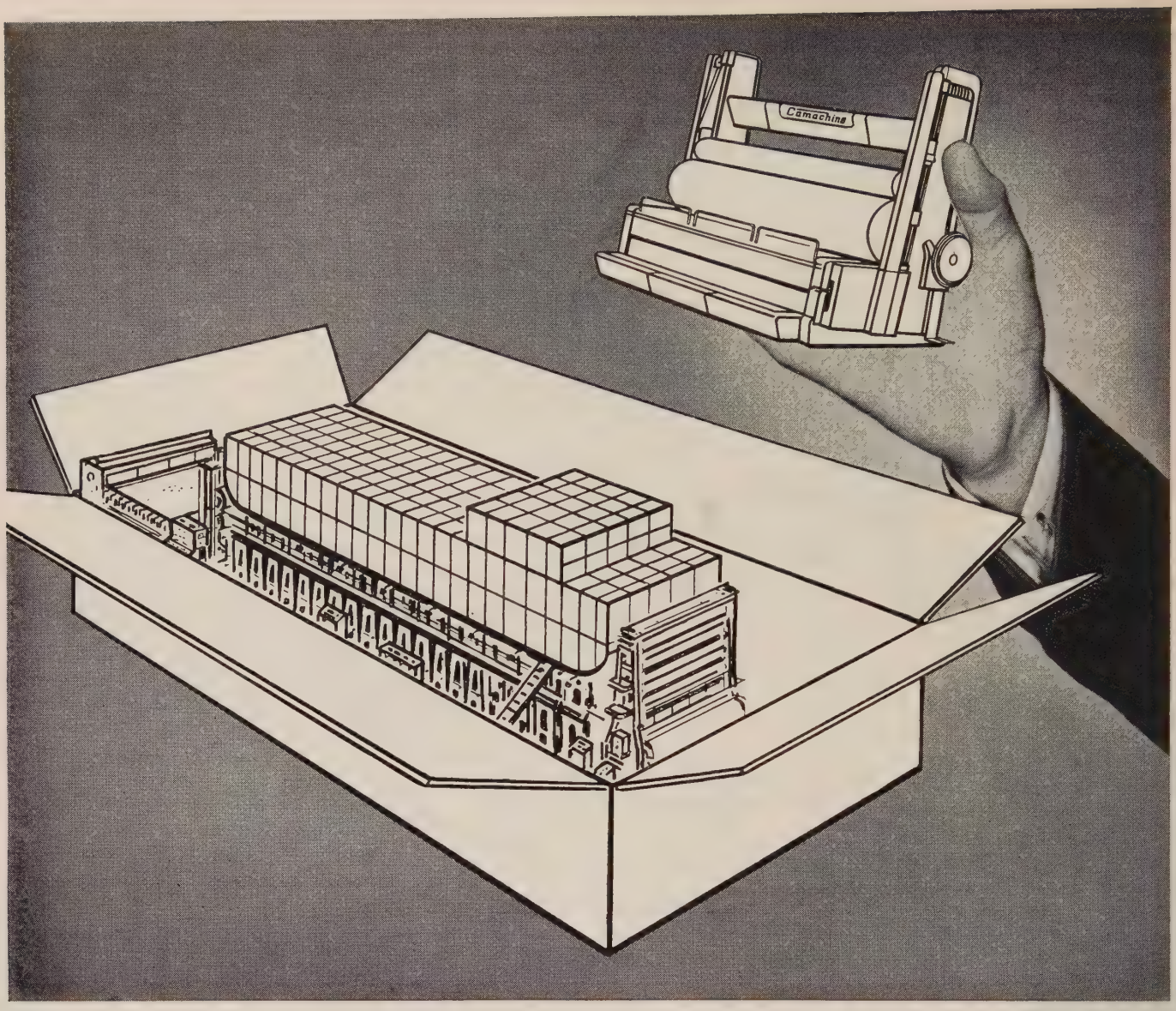

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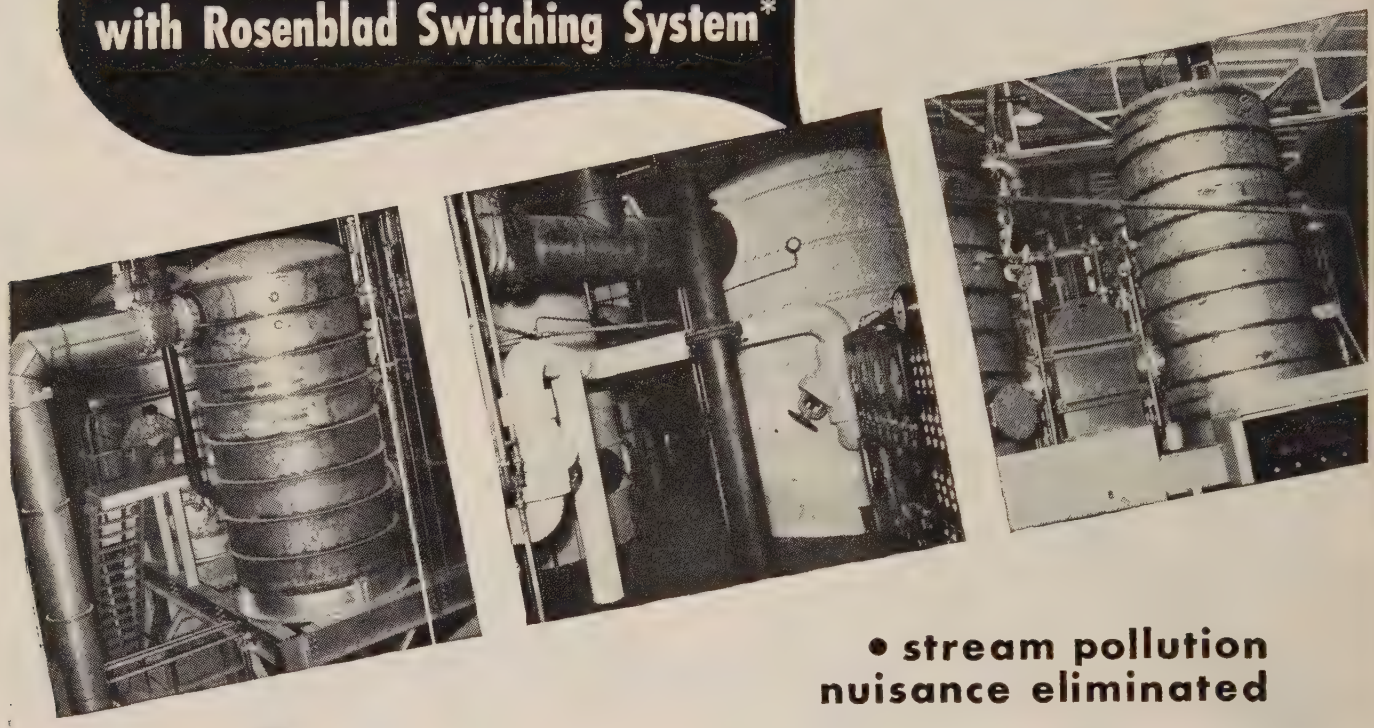

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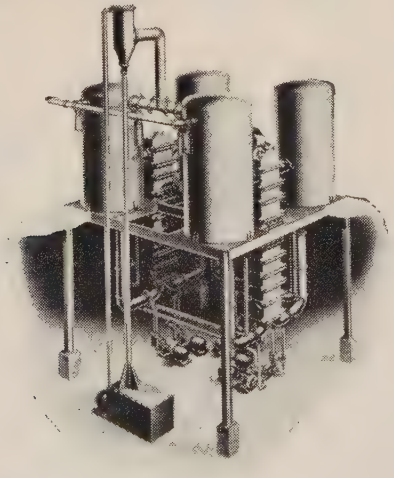

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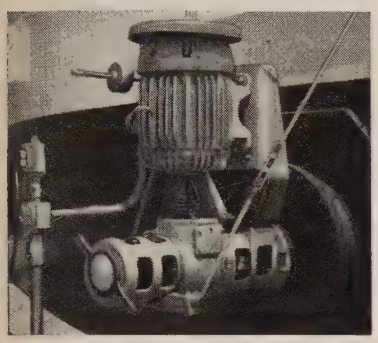

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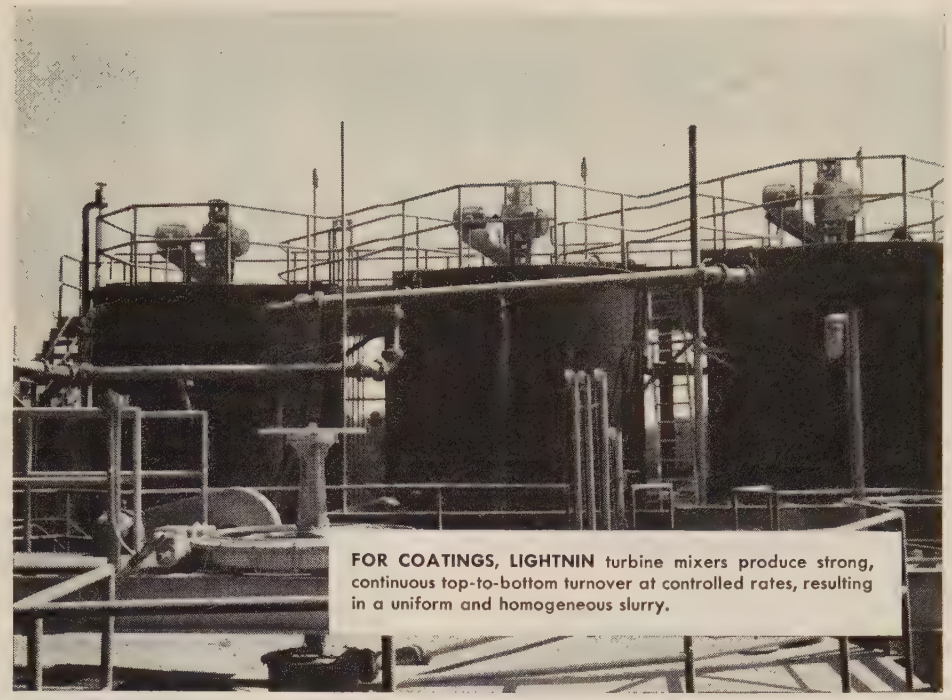

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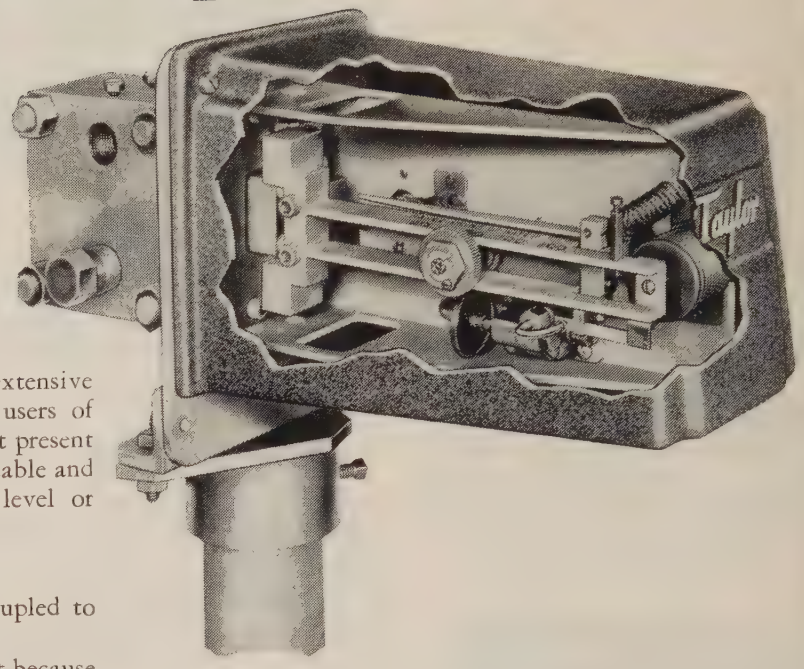

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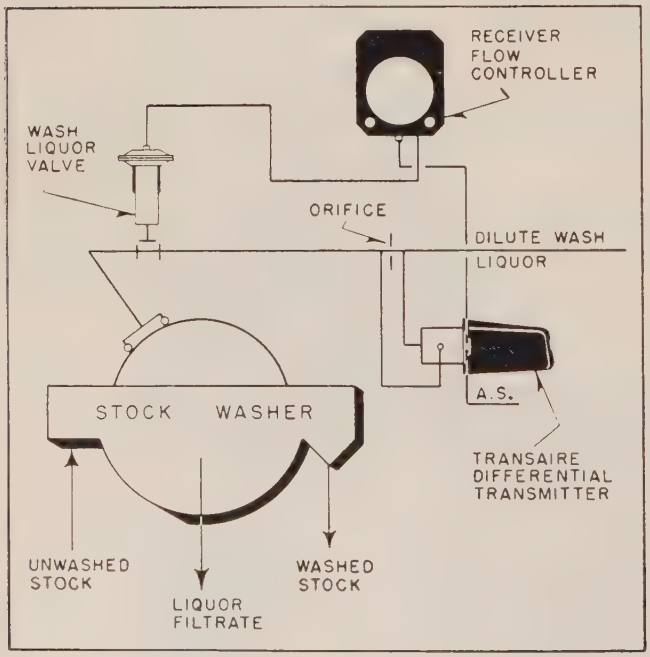

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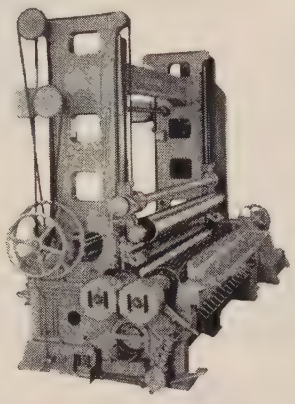

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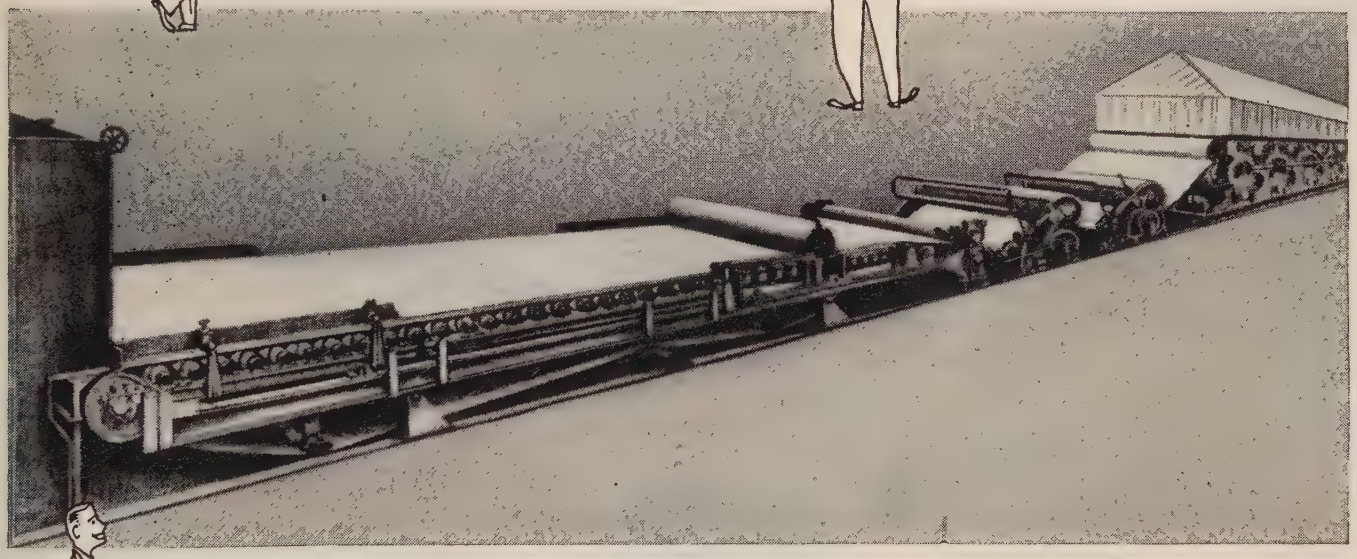

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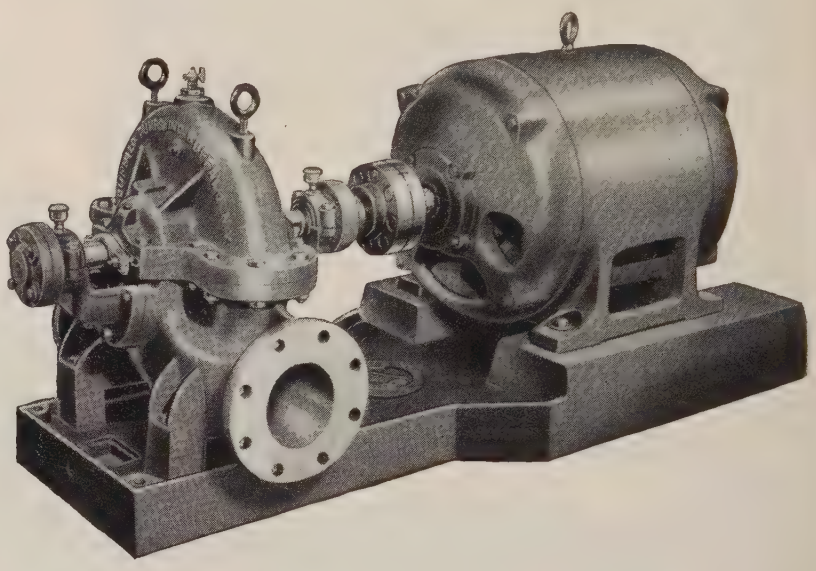

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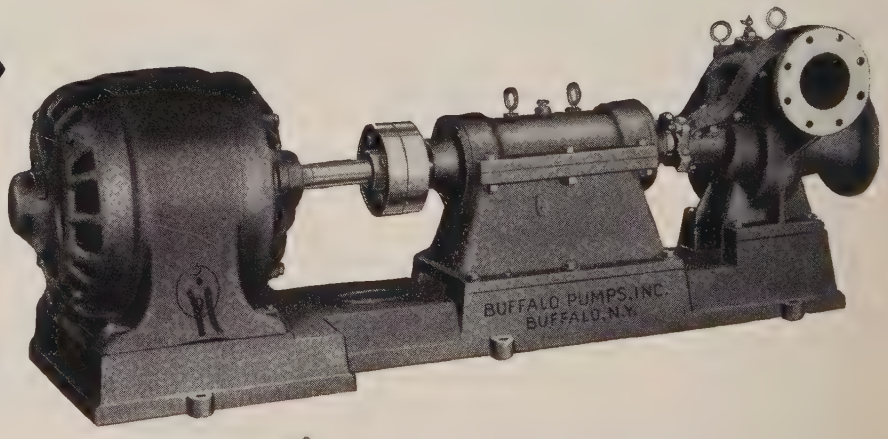

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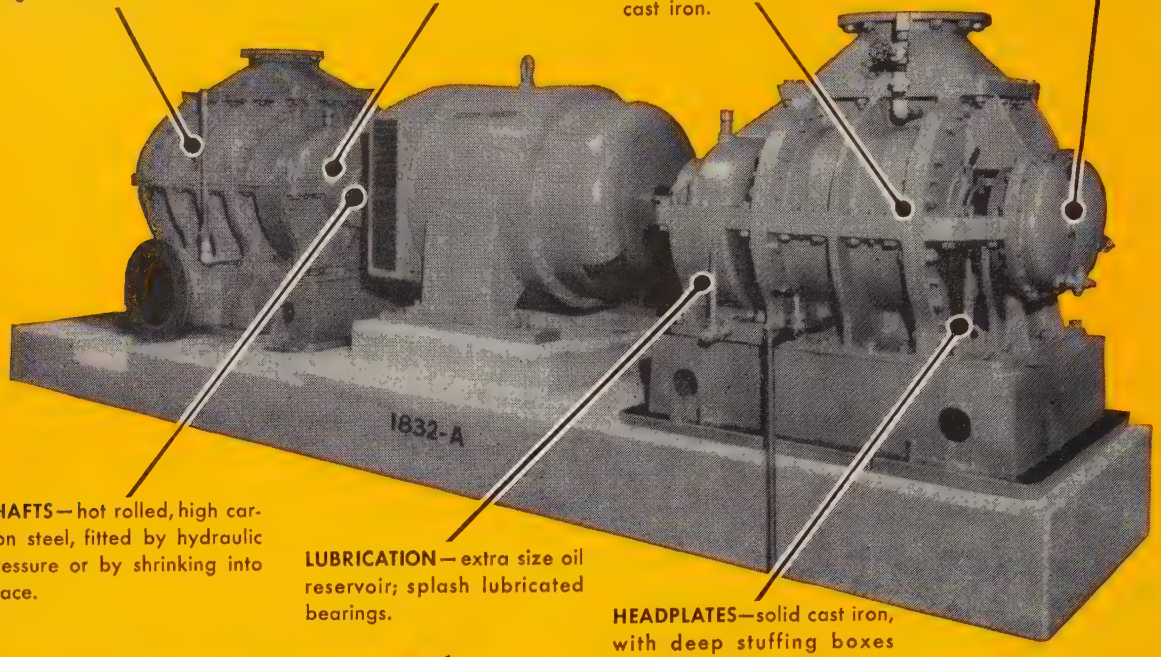

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Uneven Corrosion in Alkaline Pulping Digesters

A Major Cause and Possible Cures

FRANCIS W. FLYNN, FREDERICK H. RICHTER, and FREDERICK B. SNYDER

Several AISI type 405 alloy-lined digesters installed in 1948 experienced severe corrosion after a short period of service. Corrosion was not general throughout the digesters. Some areas were attacked but other areas were uncorroded and were covered with film and scale. The corrosion was found to result from a boiling action that takes place when small quantities of liquor contact the hot digester shell. This boiling action is similar to that occurring when small quantities of water are dropped on a hot-plate. The digester shell, following a blow, remains approximately at the cooking temperature. In refilling, heat is extracted quickly from surfaces completely submerged in liquor. When uncooled surfaces are contacted with small quantities of liquor such as result from splashing or foaming, hot-plate boiling and corrosion result. Splashing during refilling is a major source of hot-plate boiling. Corrosion in type 405 alloy-lined digesters was arrested by two methods which prevent the hot-plate boiling action. One method involves the use of a specially designed metallic digester liner, the other involves admission of filling liquor at the bottom of the digester. Hot plate boiling appears to be an important factor in causing uneven corrosion in carbon steel digesters. The methods used in arresting corrosion in type 405 alloy-lined digesters should be beneficial in reducing uneven corrosion in carbon steel digesters.

Until recent years, the kraft pulp industry was obtaining what was considered satisfactory service from carbon steel vessels in the digestion process. During and immediately following World War II, extensive plans were made for modernization and expansion of the industry. About this time a number of mills were experiencing a definite shortening of digester life. To compensate for this shortened life, the trend of thinking was toward the use of stainless steel lined vessels, but with no actual experience in this field, the mills had to rely on information collected from corrosion specimens that had been installed in their carbon steel vessels. It was upon this kind of information that AISI type 405 alloy was specified as a lining material for several digesters installed in 1948.

The AISI 405 lined vessels with which we are familiar had been in service only a short while when a severe corrosion problem developed. Study and experimentation over the past three years in connection with this corrosion problem has disclosed what appears to be a fundamental cause of corrosion in alkaline pulping digesters. This cause appears to be susceptible of practical control, and corrosion preventive measures taken in several type 405 alloy lined digesters have recently proved successful in arresting corrosion. There are strong indications that the measures applied successfully to type 405 lined digesters may also be applied to reduce uneven corrosion in unlined carbon steel digesters.

Temperature studies show that following the blowdown, the thick digester shell remains at high temperature. Where small quantities of charging liquor contact the hot shell, a boiling action takes place similar to that occurring when small quantities of water are dropped on a hot stove. It has been found that this "hot-plate" boiling action has a highly corrosive effect and is a major cause of digester corrosion.

Certain operating factors, primarily the chip and liquor charging procedures, determine the location of areas that will be subjected to this boiling action. In areas where this boiling action occurs, it has been found that corrosion rates are relatively high. In areas where this action does not occur, it has been found that corrosion rates are relatively low or that the area may be free of corrosion.

The factors causing "hot-plate" boiling are: high metal temperature; the presence on the hot metal face of small quantities of liquor; and a large mass of the metal. The mass is important since this determines the heat capacity of the metal and thus its ability to maintain a high temperature. Proper control of these factors will eliminate "hot-plate" boiling and thus prevent corrosion due to this cause.

To our knowledge, this reason for uneven digester corrosion has never before been advanced, and, we therefore, believe it will be of interest to the industry if we outline our experiences indicating that "hot-plate" boiling is a major cause of corrosion, and our experiences in preventing corrosion resulting from this cause.

It is the purpose of this paper, therefore, to describe briefly the corrosion problems encountered in several type 405 alloy lined digesters, to describe the investigation of the problem and the conclusions reached, and to describe the corrective measures applied successfully to prevent further corrosion.

It is a further purpose to point out the parallel between the corrosion patterns in type 405 alloy lined digesters and in unlined carbon steel digesters. This parallel indicates that the "hot-plate" boiling action is a major cause of corrosion in carbon steel vessels and suggests that the corrective measures successfully applied to 405 lined digesters may also be successful in carbon steel digesters.

The majority of the field work was done at the Camas mill of the Crown Zellerbach Corp., where severe corrosion of six type AISI 405 alloy-lined digesters was experienced after a short period of operation following

Francis W. Flynn, Assistant Kraft Mill Superintendent, Crown Zellerbach Corp., Camas, Wash.; Frederick H. Richter, Staff Engineer, The Babcock & Wilcox Co., New York, N. Y.; and Frederick B. Snyder, Metallurgist, The Babcock & Wilcox Co. Research and Development Center, Alliance, Ohio.

installation of the digesters in 1948. A joint investigation of the problem by the Crown Zellerbach Corp. as operator and The Babcock and Wilcox Co. as fabricator was started in 1949 and has continued to this time. Laboratory work by the fabricator, and observations

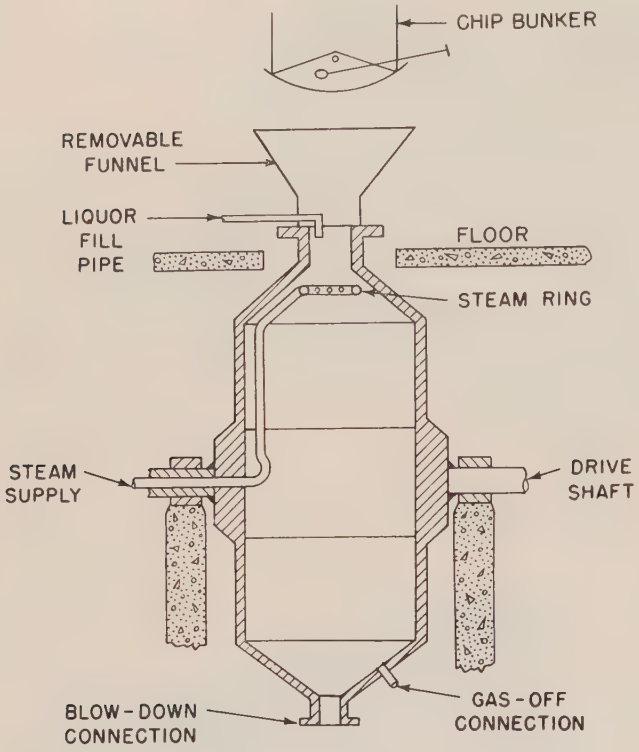

Fig. 1. Schematic cross section of rotary digester

made in other mills were correlated with the field work at Camas in the solution of the problem. Unless otherwise indicated, all field observations and experiments to be discussed refer to the lined digesters at Camas.

INVESTIGATION OF CORROSION PROBLEM IN AISI 405 ALLOY CLAD DIGESTERS

Clad Digester Installation and Operation

Although the corrosion rates on carbon steel digesters at Camas were not as high as those reported by some other mills, there was strong interest in obtaining a digester which would last indefinitely. As a matter of record, the replacement of digesters at Camas has been orderly over a period of 26 years, and the carbon steel vessels now being replaced are showing the same service life as previous digesters, with an average life of 12 years.

For a number of years corrosion specimens of various alloys supplied by digester fabricators had been undergoing tests in the carbon steel vessels at Camas. When the time came to establish specifications for stainless-lined vessels, it was the consensus of those who had observed the tests that the alloy to use was a chromium-bearing steel, AISI type 405 (12 to 14% chromium, 0.2% aluminum). As a consequence, the vessels were fabricated to the following specifications:

The shell and cones were to be of firebox quality steel according to ASME Spec. SA 201, Grade B (60,000 T.S.), clad with AISI type 405 alloy. The thickness of the carbon steel in the cone courses was to be $1^{9}/_{16}$ in., $1^{1}/_{8}$ in. in the shell courses adjacent to the cone and $3^{1}/_{4}$ in. in the trunnion or center course. The cladding was to consist of two sheets of AISI type 405 alloy each 0.054 in. thick separated from the carbon steel shell by a 0.007 in. thick nickel sheet. The cladding was to be attached to the shell by a resistance spot welding method. Circumferential and longitudinal seams were to be hand welded with 12–14% stainless electrodes, AISI type 410.

The Camas digesters, 10 in number, are of the rotating type, but only six are lined with 405 alloy. Of the six one has a capacity of 1460 cu. ft. and the other five a capacity of 1860 cu. ft. The six clad digesters were installed during the period of January to May, 1948.

About this time, a 405 alloy-lined stationary digester also went into service in a southern mill.

Since rotary digesters are not too generally used today, it might be well to illustrate one of the Camas digesters and point out the major features of construction and operation.

Figure 1 is a schematic cross section of a Camas rotary digester. The digester is supported on hollow trunnions. The steam supply is brought in through one of the trunnions to the steam ring located in the charging end of the digester. For structural reasons the center, or trunnion, course is considerably thicker than the other courses.

The digester is shown in the blowdown and charging position. Charging is accomplished in the usual fashion, the liquor being fed in through a swiveled, off-center fill pipe. Chips and white liquor are fed simultaneously, and no black liquor is added. When charging is complete, the digester is closed and is rotated one-half turn to bring the steam ring lowermost. The digester is then steamed and gassed-off in a stationary position until pressure and temperature are reached. Rotation at approximately $^{1}/_{5}$ r.p.m. is then started and is continued until completion of the cook. The digester is then stopped in the position shown, and the contents

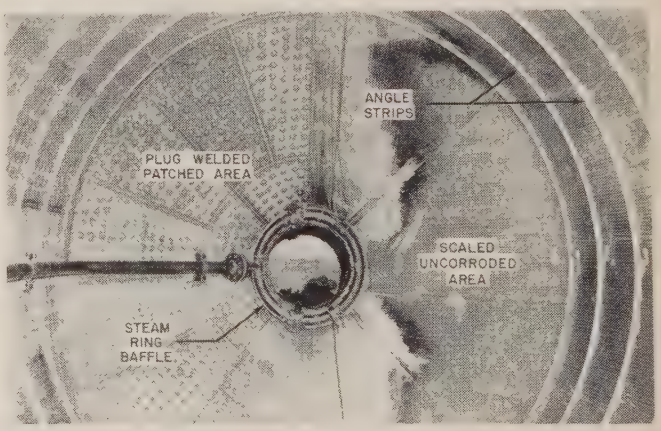

Fig. 2. View into filling and steaming end of no. 1 digester showing corroded and patched area on the left; and uncorroded, scaled area on the right. Steam ring, steam ring baffle, and angle strips are also shown

are blown in conventional manner. The digester is then ready for recharging.

Erosion Investigation

Although regular inspections were made after the vessels went into service, the complete picture of the corrosion pattern was not revealed until April, 1949. Prior inspections had shown certain areas to be covered

with a black film beneath a brownish gray scale, and other areas to be free of scale and to have a very bright appearance. The April inspection in the 1460-cu. ft. vessel (no. 1 digester) indicated that in the bright areas corrosion had been taking place to such an extent that in spots the nickel sheet between the alloy and carbon steel shell was exposed. In the bright areas, the hand welds also were attacked. The loss of metal in the no. 1 digester was more advanced than in the other five vessels, but conversely the area covered by scale was considerably greater. The same general pattern of corrosion was present in all six digesters in that most of the metal loss seemed to be taking place on one side of the vessel.

After some study of the scale and metal loss pattern it was concluded that the loss was due to erosion rather than corrosion. The erosion was thought to result from uneven circulation during the stationary steaming period caused by the position of the steam ring, the location of the steam inlet to the ring, and the slight tilt of the digester during the stationary steaming and gas-off period.

With the erosion theory in mind, it was considered necessary to patch approximately 140 sq. ft. of cladding in the no. 1 digester and to consider means of correcting the conditions causing erosion. It was felt that if liquor circulation during stationary steaming could be confined more to the center of the vessel, erosion might be minimized and a protective film and scale would form on the formerly eroded surfaces. To confine the circulation more to the center it was decided that a

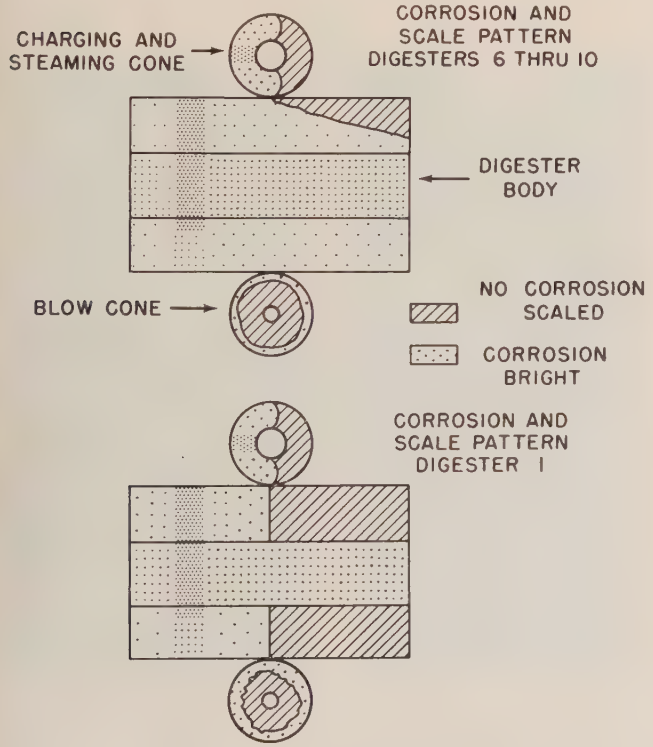

Fig. 3. Corrosion and scale patterns in six rotary digesters

baffle around the steam ring would be beneficial, and that circulation along the digester walls might be further reduced by welding in $^3/_4$-in. angle iron strips on 24-in. centers circumferentially around the shell. Figure 2 is a view into the charging and steam end of the no. 1 digester, and shows a portion of the patch job, the steam ring baffle, and the angle strips. The material used was type 405 alloy, $^1/_8$ in. thick. This figure also illustrates the film and scale formation on one side of the digester, and the bright metal on the other side.

Within a short time after the baffle and angle strips were installed, it became apparent that the erosion

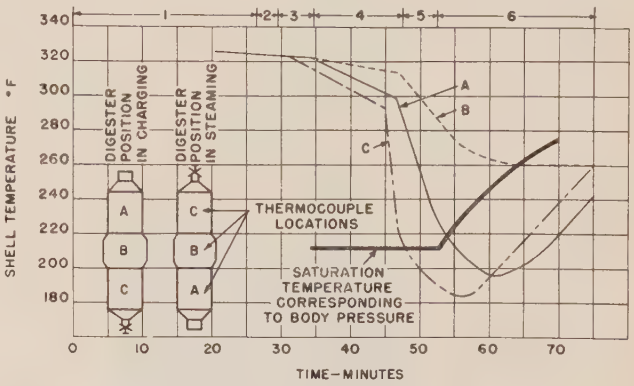

Fig. 4. Shell temperatures in rotary digester body courses during the blowing, refilling, and early steaming periods of cooking cycle

Time interval: 1, digester rotating on cook; 2, digester stationary; 3, blowdown; 4, chip and liquor charging; 5, digester rotated $^1/_2$ turn; 6, digester on stationary steaming.
——— thermocouple A. -------- thermocouple B.
—·— thermocouple C.

theory did not hold. No film or scale formed on the bright surfaces, and successive inspections showed unchecked metal lows in the bright areas.

Two striking observations were made, however, as a result of the installation of the steam ring baffle and angle strips.

The angle strips, whether attached to a corroded or noncorroded surface of the cladding, immediately took on a black film except around the small areas where the strips were tack-welded to the lining. The steam ring baffle also became filmed and scaled. It was concluded that neither the strips nor the baffle were corroding, a conclusion later borne out by actual measurement after a long exposure period. Since these attachments were of the same material as the lining, it seemed illogical at the time that the attachments should be free of corrosion while the lining in the same area was corroding rapidly. Ostensibly, the angles and lining were subjected to the same corrosion conditions. Later it was concluded that the attachments and the lining were at different temperatures during the charging period, this difference being made possible by the relatively low mass of the strips and baffle.

Film and Scale as Corrosion Indicator

It should be pointed out here that it had been concluded in our early inspections that the presence of a black film or a brown scale on the lining indicated the absence of corrosion. It had also been concluded that corrosion was present to some degree in the bright areas that had neither film nor scale. The validity of this conclusion has been demonstrated many times since then by actual measurement of corrosion rates in filmed areas and in bright areas.

The difficulty of obtaining sufficient material of the thin, black film for chemical analysis prevented its positive identification. However, its slow rate of solution in cold sulphuric acid and its positive response to "sulphur printing" with photographic bromide paper suggested that it consisted of chromium sulphide. Analysis of the brown scale indicated it to be primarily calcium carbonate.

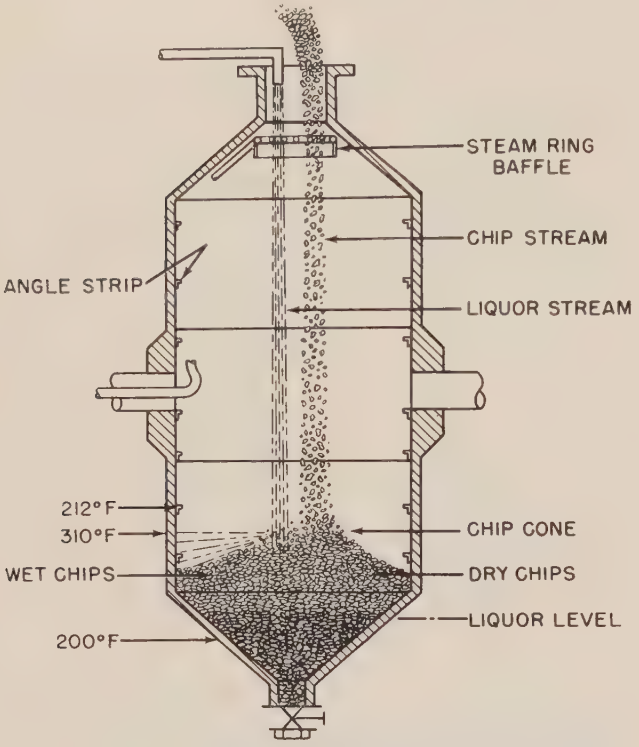

Fig. 5. Chip and liquor distribution in no. 1 digester in early stage of refilling

The filming and scaling characteristics of type 405 alloy proved to be a most valuable aid in studying corrosion since it was possible to determine visually which areas were corroding and which areas were not. It was necessary, of course, to determine corrosion rates in the bright areas by actual measurement. This was done primarily by microscopic measurement of samples removed from corroded areas. Because of the filming characteristics of the alloy, any experimental actions taken to arrest corrosion could be assessed by visually noting film and scale formations. Evaluation of these same actions on other materials having different filming characteristics would have been difficult, particularly had it been necessary to obtain corrosion measurements over a long period of time.

Corrosion Test Specimens

Another interesting observation was made shortly after conclusion of the erosion experiments. Two sets of corrosion specimens supported in racks had been installed in the severely corroding center section of the no. 1 digester. Shortly after installation, it was noted that soft chips and fibers accumulated around the specimens and between the bottom of the rack and the cladding.

The alloy cladding beneath this fiber mass was found to have taken on a deep black film, indicating that corrosion had been arrested beneath the fibers. The surrounding areas of cladding were of course still bright and corroding. The fact that corrosion had been arrested beneath the fiber mass was later made use of in several experiments that led to the development of a method for arresting corrosion throughout a digester.

Corrosion and Scale Patterns

After discarding the erosion theory, detailed studies were made in all six digesters of the corrosion and scale patterns, the chip and liquor charging procedures, and digester metal temperatures. These studies provided the clues and evidence revealing the real cause of corrosion. Before the cause of corrosion is discussed, an examination of the corrosion and scale pattern in the Camas digesters should be interesting.

Figure 3 illustrates the corrosion and scale patterns in the six alloy-clad digesters. Five of the six digesters have almost identical patterns, and the upper sketch serves to illustrate the pattern in these five digesters. The lower sketch illustrates the pattern in the no. 1 digester.

In the sketches, the digester end cones are shown as they would appear if viewed from within the digester. The cylindrical digester bodies are shown in a developed view.

The locations of noncorroded areas, which are covered with film and scale, are indicated by cross-hatching. Areas not covered by film and scale are corroded, the relative severity of attack being indicated by the density of shading in these areas, the denser the shading, the greater the attack.

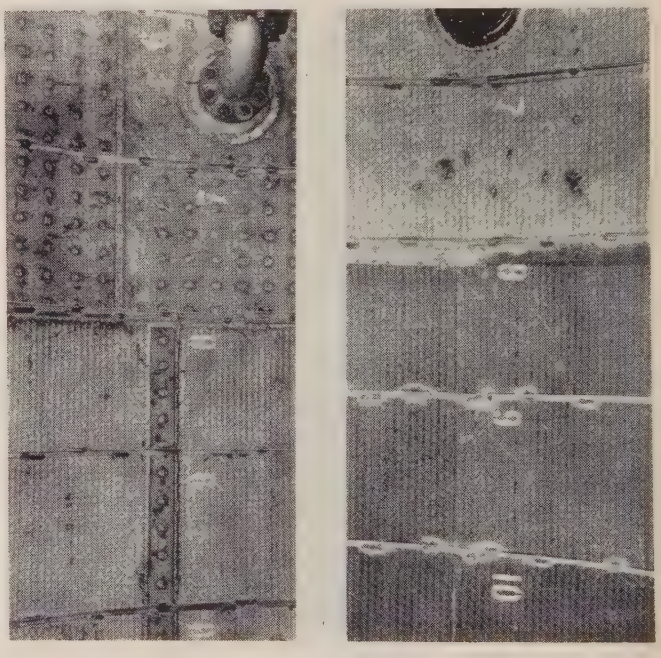

Fig. 6. Views of opposite walls of digester no. 1. Left wall is bright and corroded. Right wall, except for center course, is uncorroded and scaled

The patterns in all six digesters are seen to be similar, in that one side is more heavily attacked than the other, and that any scale present is opposite the heavily attacked side. In each of the digesters, approximately one half of the fill cone end is covered with film and

scale, and practically the whole of the blow cone is covered with a dense black film. The cylindrical center course is seen to be heavily attacked over its full circumference.

The pattern in the no. 1 digester is seen to be unique in that approximately 40% of the area is covered with film and scale as compared to approximately 10% in the other five digesters.

Study of these corrosion patterns indicated the presence of some corrosion factor that was active only on certain areas and not on others. Study also indicated that this unbalance was present to a greater degree in no. 1 digester, and suggested that there must be some difference between this digester and the other five digesters that explained the unbalance.

Some reflection on the scale and corrosion patterns indicated that the more commonly mentioned reasons for uneven corrosion did not seem to apply, or were certainly minor. For instance, vapors alone did not cause the corrosion, as evidenced by the presence of both corroded and noncorroded areas in the vapor zone. Contact with white liquor alone did not cause the corrosion as indicated by the fact that there were corroded and noncorroded areas in contact with white liquor. The same was true of black liquor. Temperature shock did not account for the attack since both corroded and noncorroded areas were subjected to the same degree of shock. Erosion alone did not seem to

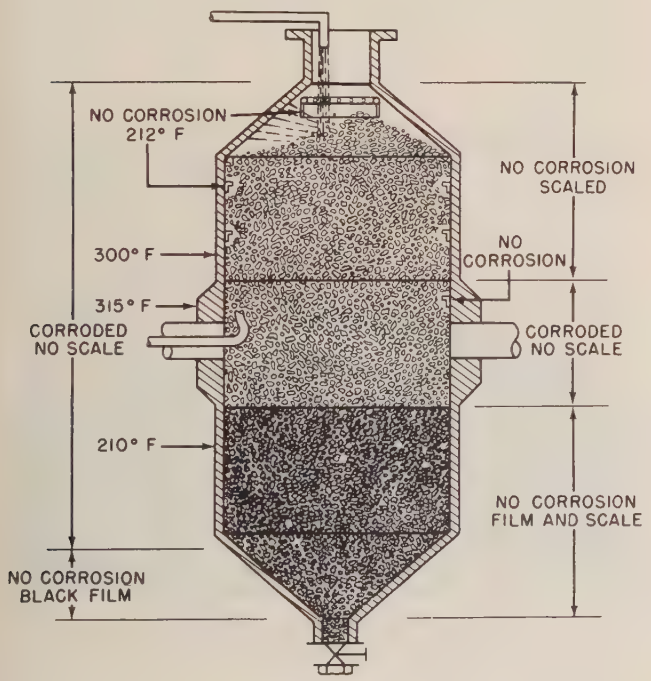

Fig. 7. Temperature and liquor distribution in digester no. 1 in latter stages of refilling. Chip feed is complete and liquor is being fed alone

be the cause of the metal loss since corroded and noncorroded areas were subjected to erosion due to digester rotation. Further, all these effects combined were present on both corroded and noncorroded areas. It thus appeared that there must be some as yet unidentified reason for the uneven corrosion.

HOT PLATE BOILING CORROSION MECHANISM IN TYPE 405 ALLOY LINED DIGESTERS

Factors in Hot Plate Boiling

Correlation of corrosion and scale patterns with chip and liquor distribution during charging, and with digester metal temperature levels, led to the conclusion that the 405 alloy corroded only where there was appreciable boiling of white liquor on the digester surfaces. Where this boiling action did not take place there was no corrosion, and film and scale were present.

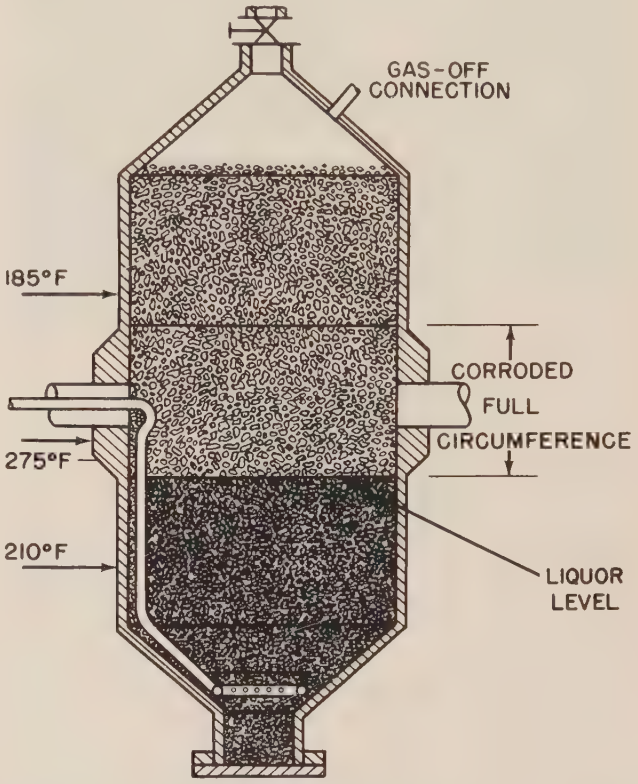

Fig. 8. Shell temperature after rotation to stationary steaming position

Most of this boiling action occurred during the charging operation when small quantities of liquor were splashed onto the hot shell.

Temperature studies showed that the digester shell immediately following a blow is at a temperature corresponding to the cooking pressure, or approximately 320 to 340°F. Due to the mass of the digester, there is considerable heat stored in the shell. When the interior surfaces are completely submerged in liquor, the heat stored in the digester walls is quickly absorbed, and the submerged portion of the shell falls to a temperature below that necessary to maintain boiling. However, if small quantities of liquor are brought into contact with the hot shell, the temperature and heat storage in the shell causes vigorous boiling of the small quantities of liquor, and may evaporate this liquor to dryness.

Figure 4 illustrates the shell temperature levels in the various sections of the Camas digesters throughout the refilling and early steaming periods of the cooking cycle, and indicates the surfaces that will support hot-plate boiling at any particular time in the cycle.

There are several actions taking place in the digester that may cause small quantities of liquor to contact the

hot areas of the shell. The charging operation may result in considerable splashing of liquor, or may cause wet chips to be carried against the digester walls. Depending on how the chips and liquor interact during charging, certain areas may be contacted with small liquor quantities and other areas may not. The large uncorroded areas found only in the no. 1 digester are explained by a difference in chip introduction which results in the complete shielding of one wall against splashing. Foaming of the liquor during steaming may

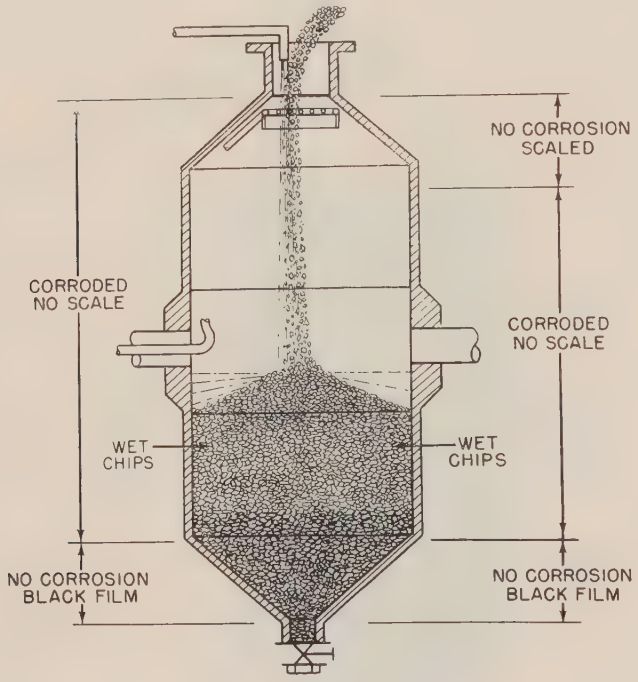

Fig. 9. Chip and liquor distribution in digesters 6 through 10 during refilling

also cause small quantities of liquor to be carried up into areas that have not been submerged and thus are still hot.

Contact between small liquor quantities and surfaces that will not support boiling results in no measurable corrosion. This was deduced from the fact that the earlier mentioned $^1/_8$-in. thick angle strips and steam ring baffle did not corrode although they were splashed with liquor during charging. Due to their low mass, and also due to the fact that they are not in intimate contact with the hot shell, these thin pieces lose their heat rapidly following the blowdown, and splashing is of no consequence.

It is not known definitely what actually takes place when white liquor boils on the hot metal face, although it seems most likely that the attack is due to the combination of high temperature and high liquor concentration caused by evaporation during the boiling period.

Illustration of Hot-Plate Boiling

With the hot-plate boiling explanation for uneven corrosion in mind, an analysis of the actions taking place in the Camas digesters during charging and early steaming should be of interest at this point. To emphasize the effect of the charging method on the corrosion and scale patterns, two digesters with differing scale patterns will be used as examples. The pertinent physical difference between these two digesters is the way in which the chips emerge from the chip funnel and flow through the charging neck.

The actions in the no. 1 digester, which has about 40% of its area uncorroded and covered with film and scale, will be illustrated first.

Figure 5 depicts a cross section of digester no. 1 shortly after the filling procedure has been started, and shows the chips and liquor being admitted simultaneously. Also shown schematically are the $^1/_8$-in. thick angle strips and $^1/_8$-in. thick steam ring baffle. As mentioned earlier, these were installed in connection with the erosion investigation, and experienced no measurable corrosion even where attached to the rapidly corroding shell.

The shell temperatures shown were determined by measurement. The heat storage of the angle strip and steam ring baffle is assumed to be too low to support appreciable boiling and their temperatures have arbitrarily been indicated to be 212°F. since contact with small amounts of liquor will quickly cool them to this temperature.

It will be noted that due to the charging arrangement of the no. 1 digester, the stream of chips emerging from the funnel overshoots the liquor stream and the two streams fall separately to the bottom of the digester where an off-center chip cone forms. The liquor stream strikes this cone on its slope and splashes liquor on the left wall, where vigorous boiling takes place. This has actually been observed by stopping the chip flow momentarily while continuing to feed liquor. Additional small quantities of liquor are carried against the left wall by chips which have been wetted by the liquor stream.

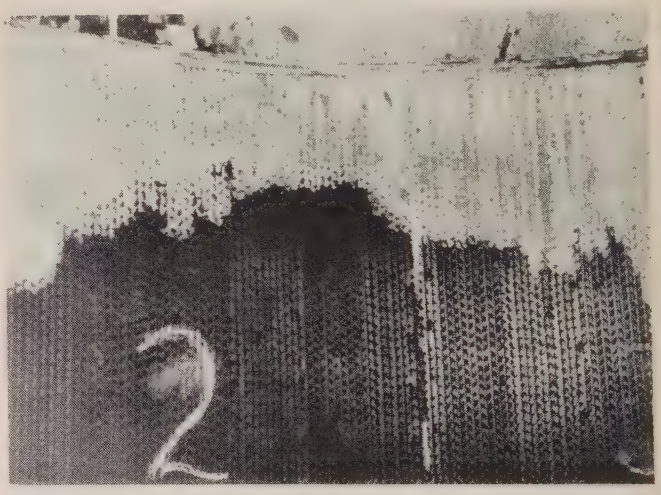

Fig. 10. Bright, corroded area in vapor zone of stationary digester

The right wall of the digester is shielded against splashing liquor by the falling chips and by the top of the chip cone. Also, the chips in contact with the hot portion of the right wall have not been wetted by the liquor stream.

The left wall of the digester on which hot-plate boiling occurs is corroded, whereas the right wall on which no boiling occurs is uncorroded. Figure 6 illustrates the appearance of the two walls at the elevation under consideration. The left hand portion of the figure shows the corroded left wall. The right hand portion

shows the right wall which is uncorroded and scaled in the lower course and bright and corroded in the center course. The sharp transition from scaled to nonscaled surfaces seen on the right hand wall occurs at the junction of the lower cylindrical course and the thick center course. The explanation for this transition will be given later. On the left wall, it will be seen that corrosion had progressed to the point where patch plates were required in the center course, and over a hand seam weld in the lower course.

Figure 7 depicts the chip and liquor levels just before charging is completed and shows the shell temperature at this time. The rate of feed of chips and liquor is such that the chip feed is completed first, so that as the charging period nears its end liquor is being fed alone. Under these conditions, one side of the digester top cone is splashed heavily while the other side is completely shielded by the top of the chip cone. The steam ring baffle is also splashed during this period. Reference to Fig. 2 will indicate the characteristic scale pattern in the top cone which results from shielding by the chip cone.

It is evident from the foregoing illustrations that as the chip cone level rises from bottom to top, the left wall of the digester is splashed for its whole height and boiling of liquor on the hot shell surfaces takes place with corrosion resulting. The alloy angle strips are also splashed, but no appreciable boiling can take place due to their low heat storage, and there is no corrosion. The right wall of the digester is shielded against splashing throughout, and except for the center course, this wall shows no corrosion and is covered with film and scale.

With charging complete, the liquor level is just below the center course. The top head is bolted on and the digester is rotated one half turn to the steaming position. Steam is turned on and the digester charge is

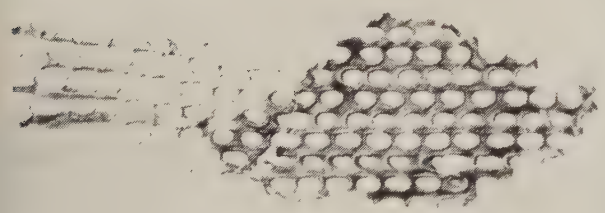

Fig. 11. Section of failed cladding

brought up to cooking pressure and temperature with the digester held stationary.

Figure 8 depicts the digester position and indicates the temperature of the various sections immediately after the one-half rotation to the steaming position. It is seen that all surfaces have now been quenched below the boiling temperature except for the thick $3^1/_4$-in. center course. The heat storage here is high and even though this section has been partly submerged during the one-half rotation, the average temperature of this section is approximately 275°F. and will still support boiling. It can be visualized that when steam is turned on, foam is carried up into contact with this hot section and hot-plate boiling takes place. Tem-

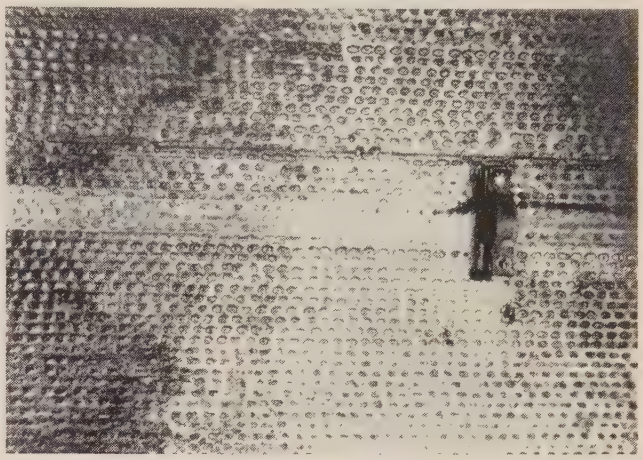

Fig. 12. Protected cladding behind steam line

perature studies show that the center section is never quenched, and thus will support boiling until the temperature of the liquor and chips has been raised by steaming. It is felt that hot-plate boiling that occurs after the rotation to the steaming position explains the fact that the center course corrodes over its full circumference, even though half of it is shielded against splashing during the charging period. The left wall of the thick center course, which is one of the most severely corroded sections in the digester, is subjected to hot-plate boiling during both the filling and early steaming periods. The right hand wall of this course is shielded during the filling period, but is corroded during the early steaming period. The corrosion rate, however, is considerably less than on the left wall. Any foam carried up into the top course has no effect since this course has been quenched and will not support boiling.

The foregoing figures have illustrated that all surfaces on which appreciable boiling occurs are corroded. The surfaces not subjected to this boiling action are not corroded and are covered with film and scale. They have also illustrated how the charging setup and methods determine largely which areas are corroded and which areas are not corroded.

The temperatures and actions in the other five digesters are similar to those illustrated above for the no. 1 digester, except as affected by the difference in the way in which the chips enter and leave the charging neck. This difference results in less shielding against splashing, and explains why these digesters have less scale than the no. 1 digester. This is illustrated in Fig. 9. which shows that the chip stream does not overshoot the liquor stream as it does in the no. 1 digester, and the two streams merge in the charging neck. Thus the liquor stream strikes the chip cone inside the digester more nearly on its apex, and liquor can splash to all walls. Also, wet chips are in contact with both walls. Due to the off-center location of the liquor fill spout, the left wall is splashed more heavily than the right

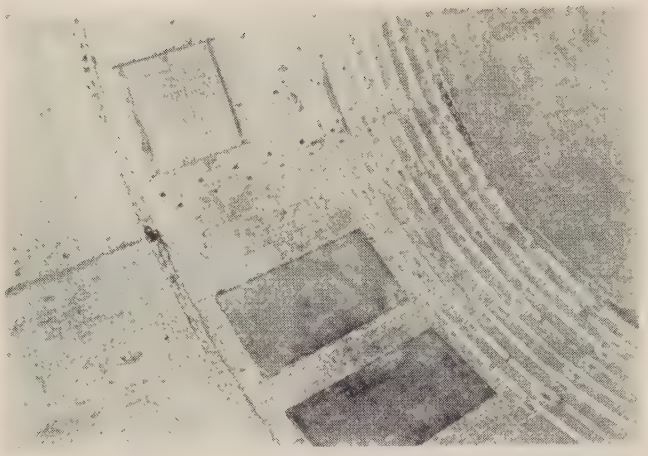

Fig. 13. Wire mesh and plate type spaced liner installation in rotary digester

wall and the corrosion rate is considerably higher on the left wall. Due to less shielding by the chips, and the wetting of the chips in the digester neck, practically all surfaces are subjected to hot-plate boiling and there is little scale in the cylindrical sections of the digesters. However, the top cones are shielded during the latter part of the charging period, as previously illustrated for the no. 1 digester, and the same scale and corrosion pattern results in the top cones.

Further Verification of Hot Plate Boiling Theory

After it was concluded from field observations and experiments that hot-plate boiling was the major cause of corrosion in the Camas digesters, considerable confirming laboratory work was done, indicating that hot-plate boiling has a highly corrosive effect; not only on type 405 alloy, but on other commonly used materials. This work is quite extensive and it is planned to present these results in detail at a later date.

The results of several other field experiments and observations added further evidence as to the severe effects of hot-plate boiling on 405 alloy. The most interesting of these will be outlined briefly.

Temperature and charging studies were made on the previously mentioned 405 alloy-clad vessel in one of the southern mills. There is no measurable corrosion in this digester except in certain areas in the so-called vapor zone, and with the exception of these areas, the entire vessel is coated with film and scale. Figure 10 shows a typical bright, corroded area in the vapor zone and indicates the character of the film and scale that covers the remainder of the vessel. The general lack of corrosion in this digester, we feel, is due to the manner in which it is charged with chips and liquor. The digester is filled completely with chips before any liquor is admitted, and thus there is no splashing of liquor during charging except that which occurs above the chip level. Temperature studies showed that, as in the case of the Camas digesters, the shell is quickly quenched when completely covered with liquor, but substantially all areas above the liquor level remain well above the saturation temperature throughout the charging and early steaming period. Thus, any liquor splashed on these surfaces during charging, or carried up into this region by foaming, will result in hot-plate boiling on these surfaces.

At Camas, after an insight into the mechanism of corrosion had been obtained, efforts were directed toward developing some means of preventing further corrosion. Since it appeared that hot-plate boiling and corrosion could be prevented by proper reduction of metal temperature, some consideration was given to cooling the digesters between cooks. Economic and production factors discouraged the continuous use of any such procedure, primarily because of heat loss from the system and the time consumed in quenching the shell. However, one experimental trial on a single digester substantiated the hot-plate boiling explanation for corrosion and demonstrated that corrosion of the cladding could be retarded by adequately cooling the shell. In this trial, a set of water nozzles was inserted into the digester immediately after each cook, and before recharging the digester. A fine spray of water was directed onto the cladding for a time sufficient to reduce the shell temperature to substantially atmospheric saturation temperature. The steam resulting from this quenching was allowed to escape to

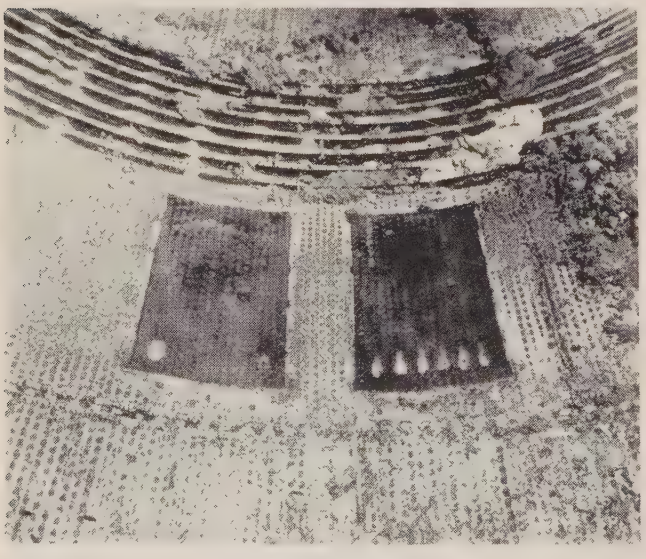

Fig. 14. Protected areas under plate type liners immediately after liner removal

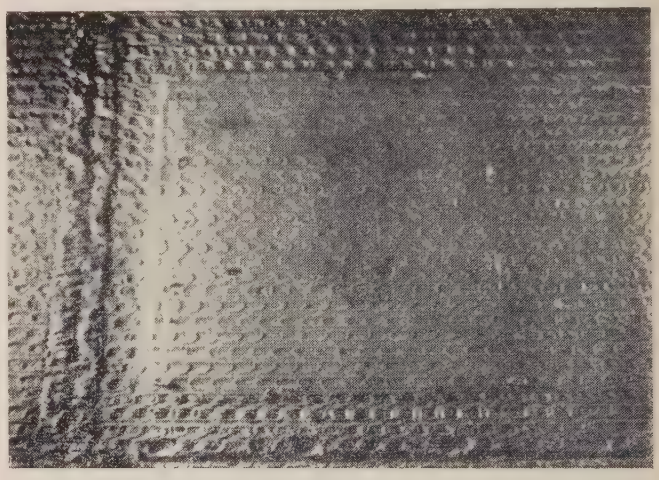

Fig. 15. Protected area under mesh type liner immediately after liner removal

atmosphere through the charging neck. After the shell had been quenched, the normal charging procedure was carried out. This procedure was followed for 11 days, cooling the shell after each cook. An inspection at the end of this time showed that a uniform light, black film had formed on the formerly bright and corroding areas. The presence of this film indicated that corrosion had been arrested. The areas that were normally covered with scale showed no ill effects from this quenching. A return to normal cooking routines caused the new film to disappear in a very short time.

Needless to say, the observations and experiments described above were made over a long period of time, and corrosion in the bright areas of the Camas digesters was still going on. At the time that full scale protective measures were put into effect, the cladding in each of the digesters had corroded through in areas amounting to approximately 30% of the surface. Further verification of the effect of temperature on corrosion of 405 alloy is shown in Fig. 11, which shows a piece of corroded and perforated cladding that had become partly detached from the shell. The bright left hand portion

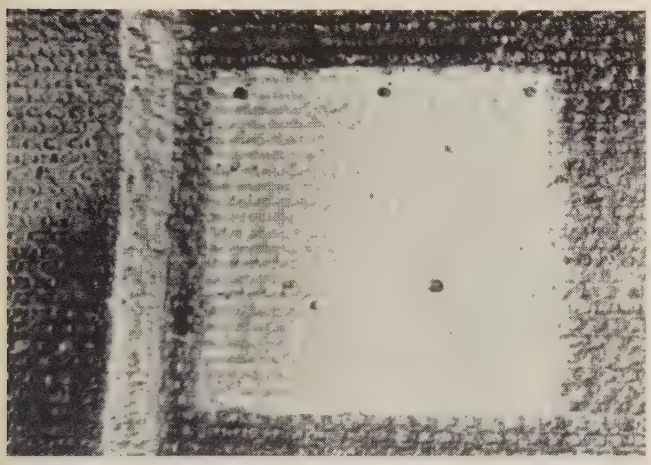

Fig. 16. Appearance of area protected by mesh liner after short operating period following liner removal

was still attached to the shell and had to be removed with a chisel. Its bright appearance indicates that it was still corroding when removed. The right hand portion had come loose from the shell and had taken on a black film. Thus, when the cladding failed, the portion of the cladding that remained attached to the hot shell continued to corrode, whereas the portion that became loosened from the shell could not support boiling, and corrosion on this portion was arrested.

Figure 12 illustrates how protection against splashing of liquor during charging results in lowered corrosion rates in the protected area. This photograph shows an area of the digester wall in the vicinity of the steam line which runs from one of the trunnions to the steam ring. The steam line, which was removed for this photograph, is so located that it shields the cladding behind it from direct splashing of liquor during charging. The protected area behind the steam line is seen in the photograph as a relatively uncorroded horizontal band. Note that the cladding surrounding the protected band had corroded through.

Fig. 17. Corroded area in stationary clad digester before spaced liner installation

PREVENTION OF HOT PLATE BOILING

Corrosion resulting from hot-plate boiling may be prevented by proper control of digester metal temperature and by proper control of liquor distribution during charging and early steaming. Two methods for doing this have been successfully applied to type 405 alloy lined digesters. One method utilizes a specially designed, nonpressure-tight, metallic liner for the digester. The other involves a change in the method of charging the digester with liquor.

Spaced Liner in Rotary Digester

It was mentioned earlier, in connection with the corrosion specimen racks installed in the no. 1 digester, that pulp fibers held next to the shell had effectively stopped corrosion of the cladding. Several observations had also indicated that thin sections of alloy not in intimate contact with the hot shell did not corrode. It seemed possible that by combining these two effects, a digester liner could be constructed that would shield the pressure shell against splashing liquor, and at the same time would trap pulp fibers and hold them against the pressure shell. This liner would be of light material so that it would be corrosion resistant, purposely would be made nonpressure-tight, and would be spaced

Fig. 18. Exposed face of spaced liner in vapor zone of stationary digester after 3 months' service

away from the shell so that liquor and pulp fibers could enter the space between liner and shell.

To explore the possibilities of such a liner, several experimental liner sections were installed in the severely corroding center section of one of the Camas digesters.

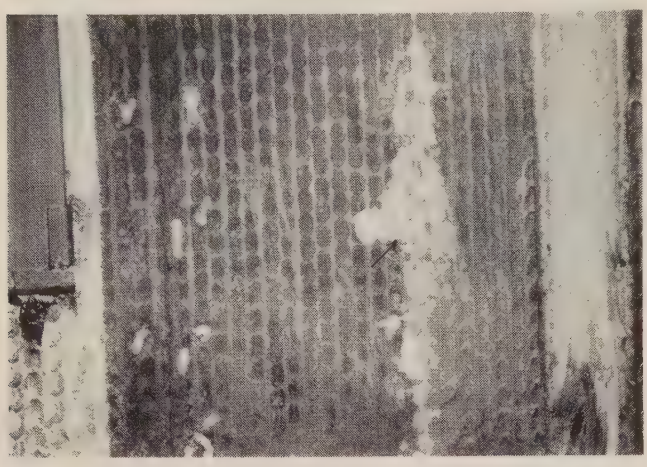

Fig. 19. Film formation on cladding beneath spaced liner

Figure 13 shows these liner sections immediately after installation, and shows the appearance of the cladding in the center course. It will be noted that corrosion had progressed to the point where the cladding had been perforated in places. The liner sections were made of 405 alloy and all were spaced about $^1/_2$ in. away from the shell. One of the sections utilized a wire mesh arrangement as a liner; the other two utilized $^1/_8$-in. thick alloy plates. One of these plates was provided with $^1/_2$-in. diameter holes on 2-in. centers, the other was provided with only four of these holes.

Periodic inspections showed that corrosion of the cladding had been arrested beneath all three liner sections. None of the liners showed any indication of corrosion, and all were covered with a uniform black film. Fibers were trapped and retained by all three liner sections, and when the void between the liner and the shell became solidly filled, a black film formed on the cladding.

The liner sections were left in place for a time sufficient to indicate their effectiveness in preventing corrosion. Figure 14 shows the cladding immediately after removal of the two plate liners. The protected areas are seen to be covered with a black film. The corroded condition of the cladding surrounding the protected areas is also evident.

Figure 15 shows the protected area immediately after removal of the wire mesh. It might be mentioned that the perforations visible in the cladding were present before the mesh was installed. Not too evident from the photograph is the fact that the protected area under the mesh existed as a plateau approximately $^3/_{16}$ in. higher than the surrounding metal.

None of the liners was replaced after removal and after a short period of operation without the liners in place, all the black film was lost from the formerly protected areas. Figure 16, taken several months after removal of the wire mesh, shows how the film had disappeared.

Although we are not certain of the reasons for the success of the spaced liner, we visualize the actions taking place to be somewhat as follows: during the cook, pulp fibers and liquor enter the space between the liner and the shell, and in time a fibrous mass accumulates. At blow-down, the liquor in this wet mass flashes to atmospheric pressure and temperature. Heat may then be transferred from the liner and the shell to the trapped liquor. The thin liner is reduced in temperature and some cooling of the shell takes place. The pulp fibers also act as insulation to prevent the thin liner from regaining heat from the thick shell, and promote the growth of film and scale. During charging, the thin liner and the fibers prevent liquor from being splashed onto the shell. The thin liner, even though splashed with liquor, loses its stored heat and temperature rapidly and does not corrode.

Spaced Liner in Stationary Digester

Because of the promising results obtained with the experimental liner installations at Camas, a spaced liner installation was made recently in the previously mentioned 405 lined stationary digester in a Southern mill. This vessel was corroding only in the vapor zone. Approximately 40 sq. ft. of this area was covered by a plate-type spaced liner, which was made of $^1/_{16}$-in. thick 405 alloy plates spaced $^1/_2$ in. from the shell.

The liner stopped corrosion in a very short time as indicated by the dense black film formation on the cladding. The liner plates show no corrosion and are covered with film and carbonate scale.

Figure 17 shows the corroded bright area of cladding over which the liner was applied. Figure 18 depicts the exposed face of the liner after three months' service, and shows the film and scale built up in this short time.

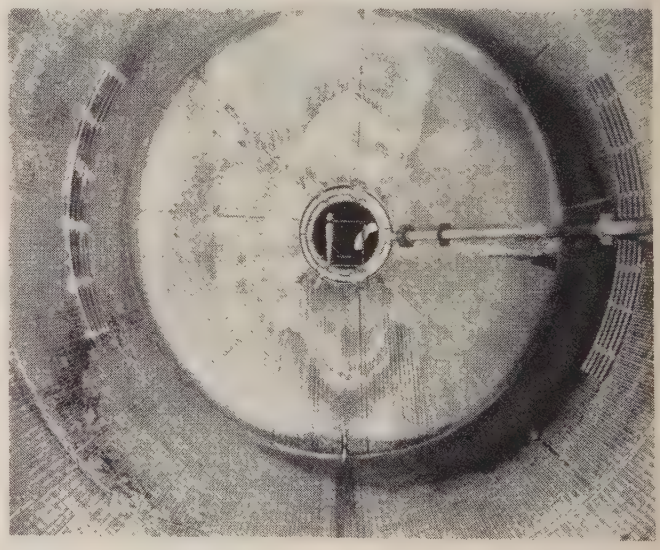

Fig. 20. Corrosion and scale pattern in charging and filling end of digester before starting bottom liquor filling procedure

Figure 19 shows a small area of cladding beneath the liner, and shows the characteristic black film formation in the protected areas. At the time the photograph was taken, pulp fibers had not completely filled the

void between the liner and shell and consequently there are still some bright areas in evidence. Later inspections have shown the black film to be continuous beneath the liners. It is interesting to note that sufficient fibers are carried up into the vapor zone by foam to cause the void between liner and shell to become filled.

Bottom Liquor Admission

The major portion of the corrosion at Camas appeared to result from splashing of liquor during charging. The simplest means of eliminating the splashing, and thereby corrosion, seemed to be to add the charging liquor at the bottom of the digester rather than at the top.

Since it is not possible to connect a liquor filling line into the bottom of a rotary digester without some drastic alterations, a line was installed inside one of the digesters to carry the liquor from the top to the bottom. With this line installed, chips are fed in the usual fashion, and liquor is introduced into the fill line at the top through a coupling arrangement that can be broken for rotation. The fill line continues down the inside of the vessel to the top of the lower cone and is open-ended at this point.

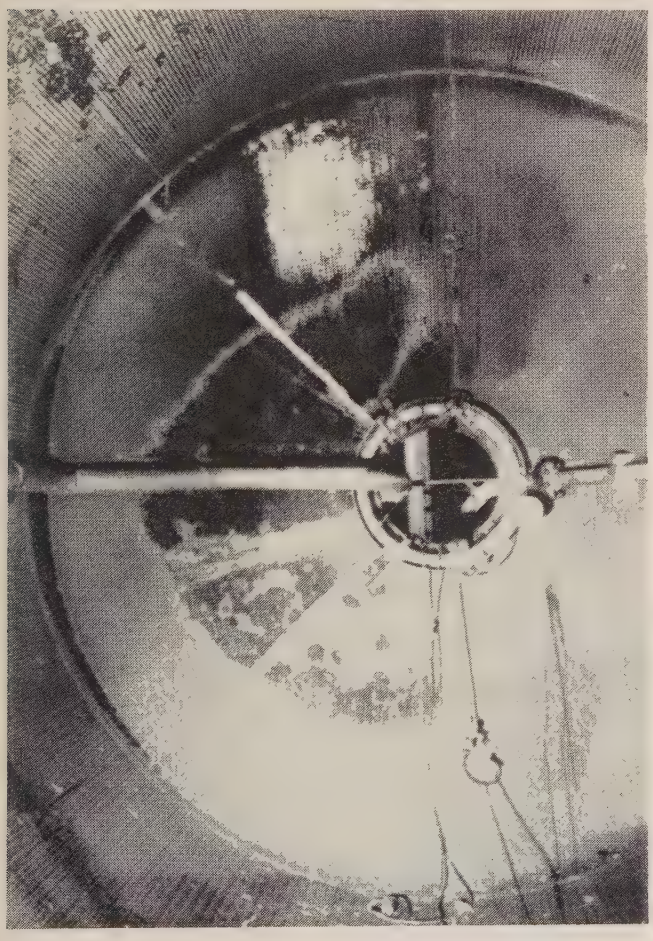

Fig. 21. Scale pattern in charging and filling end of digester after 2 months of bottom filling

The effectiveness of this filling procedure in arresting corrosion was apparent after a very short operating period. An inspection at the end of 2 months time indicated a heavy film and scale formation in areas that had always been bright and had never before been covered with film or scale.

Two photographs, one taken before and one after bottom filling of liquor was instituted, will give some idea of the resulting scale growth. Figure 20 is a view into the charging and steaming cone of the digester before bottom filling. The right hand section of this cone has always been partly covered with scale, while the left hand section has been bright and corroded. Figure 21, taken after 2 months of bottom filling, shows how the scale has spread to cover almost the whole cone area. The dark area on the left is carbon steel that has become exposed as a result of corrosion of the cladding. The pipe seen entering the digester on the left is the liquor pipe added to carry the liquor to the bottom of the digester.

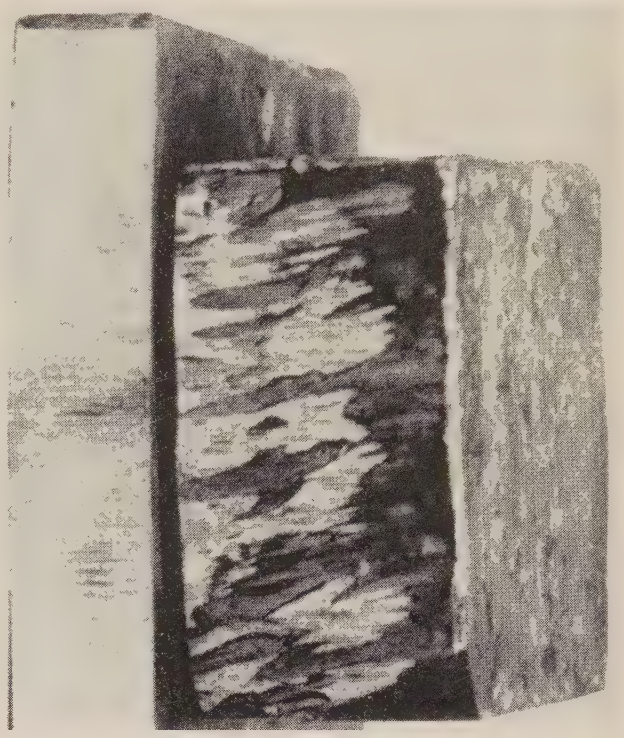

Fig. 22. Two sections cut from diametrically opposite points of retired carbon steel rotary digester. Thinner section splashed during refilling; thicker section partially shielded against splashing

There remain in the digester certain small areas that are bright, particularly in the thick center course at a level judged to be the level of the liquor at the start of the cook. With these exceptions, the 405 alloy in the vessel has ceased to corrode.

UNEVEN CORROSION IN CARBON STEEL DIGESTERS

Based on the experiences outlined above it may be concluded that hot-plate boiling is the major cause of corrosion in AISI 405 alloy lined digesters, and that corrosion may be minimized by preventing this action from taking place.

The factors necessary to the occurrence of hot-plate boiling are of course present in carbon steel digesters. There are some good indications that hot-plate boiling accounts for much of the corrosion in carbon steel vessels, and there are indications, too, that areas pro-

tected against this action will show relatively low corrosion rates.

Visual determination of the corrosion patterns in carbon steel digesters is not as clear-cut as it is in 405 alloy lined digesters, primarily because of the different filming and scaling characteristics of the two metals. However, based on Audigage readings and visual examination of a number of carbon steel digesters in various mills, the scale and corrosion patterns generally seem to be in line with what would be predicated based on the experiences at Camas. The patterns appear to be related to the liquor distribution during charging and early steaming, this distribution depending in large measure on the manner in which the chips and liquor interact to cause some surfaces to be subjected to hot-plate boiling and other surfaces to be shielded against this action. In some of these vessels where shielding was very evident, the shielded areas were covered with carbonate scale and showed little corrosion.

As in the case of the 405 alloy-lined digesters, observations regarding the formation of carbonate scale in carbon steel digesters suggest that the presence of scale is merely an indicator of low corrosion rates in the scaled area. Although it seems likely that the scale might afford some protection to the metal during the pressure phase of the cook, it has been demonstrated that carbonate scale will not protect the metal against the boiling action of the liquor, nor can the scale be maintained under this action. This was demonstrated at Camas by relocating the liquor fill pipe 90° away from its original position so that liquor could impinge on the chip cone and be splashed on areas that had always been covered with scale. After a short period of operation in this fashion, the scale and corrosion pattern shifted 90° in step with the liquor fill pipe. The scaled areas which were then subjected to the liquor boiling action lost their scale and started corroding, the bright and corroding areas from which the boiling action was removed became scaled.

A striking example of the effect of hot-plate boiling on carbon steel is shown in Fig. 22. This figure shows two sections of metal cut from a retired, unlined vessel at Camas. The sections were cut from diametrically opposite points of the cone at the charging end of the digester. The thinner section was taken from an area that was splashed with charging liquor during the filling operation. The thicker section was taken from an opposite area that was partly shielded against splashing by the top of the chip cone, and by the steam line leading to the steam ring. The corrosion rate on the splashed side is approximately 100% higher than on the shielded side.

The observed similarities between 405 alloy and carbon steel when subjected to hot-plate boiling, and when shielded against this action suggest that the protective methods—spaced liners and bottom liquor admission—developed in our work on 405 alloy-lined digesters are also applicable to carbon steel digesters.

Several mill trials using these methods on carbon steel digesters have recently been started. The Camas mill is now using bottom liquor admission on a recently installed stationary carbon steel digester. Also, an experimental spaced liner installation has been made in a corroding stationary carbon steel digester in a Southern mill. None of these trials has been in effect long enough for any conclusions to be drawn as to their effectiveness in minimizing corrosion of the shell. It is interesting to note, however, that the carbon steel liner panels in the Southern mill show little corrosion after 6 months' exposure. Figure 23 shows this installation, and it will be seen that the mill scale on the liner is still practically intact after 6 months service. It might be mentioned here that, assuming the liner protects the pressure shell against corrosion, some corrosion of the liner itself could be tolerated since sections of the liner may be replaced easily if necessary. Commercial liner designs have been prepared with this consideration in mind.

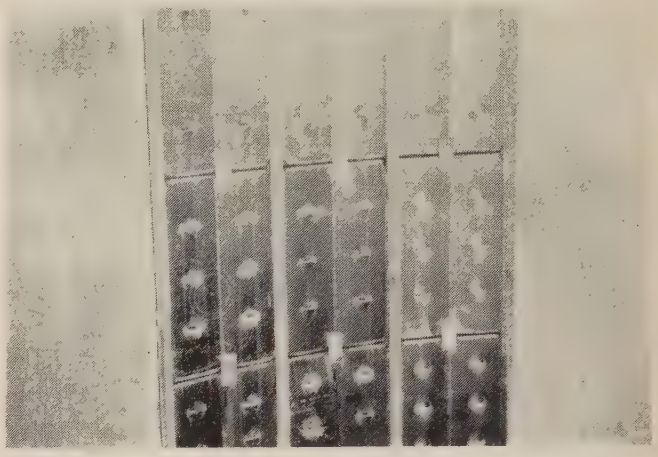

Fig. 23. Exposed face of carbon steel spaced liner in carbon steel digester after 6 months' service

CONCLUSION

In conclusion, it can be stated that a hot-plate boiling action resulting from contact of small liquor quantities with hot digester surfaces is the major cause of corrosion in the type 405 alloy-lined digesters which have been discussed. Corrosion in these vessels has been successfully arrested by two methods which prevent the hot-plate boiling action from taking place.

There are indications that hot-plate boiling is a major cause of uneven corrosion in carbon steel digesters. The two methods used to arrest corrosion in type 405 alloy-lined digesters—bottom liquor admission, and the use of spaced liners—should prove beneficial in reducing uneven corrosion in carbon steel digesters.

Changes in cooking practices in recent years have been generally in a direction that would promote the occurrence of hot-plate boiling, and heighten its effects. These changes may thus be a partial explanation for the shortened digester life experienced in recent years.

With this thought in mind, it is suggested that all mills compare their operations today to that period in which satisfactory life was obtained on such points as: (1) cooks per day per digester, (2) cooking temperatures, (3) digester insulation, (4) down-time between blowing and refilling, (5) filling operation as regards chip and liquor distribution during filling, (6) rate of filling, and (7) use of high-pressure pumps in filling.

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Preparation of Hardboard from White Oak

S. L. SCHWARTZ

When hardboard from white oak defibrator pulp was experimentally produced, peculiarities of pulp behavior were observed that can probably be attributed to the tannins and tanninlike substances in the wood. Disproportionately large amounts of affixing chemical—alum or ferric sulphate—were required to set the size in the white oak hardboard stocks. Peculiar, too, was the fact that a certain amount of size—rosin or paraffin—was required to secure hardboards of optimum flexural strength. This amount of size lay in the range of 0.75 to 1.0%. Amounts of size lower than this critical quantity, though adequate to impart water resistance to the boards, produced lower flexural strength. Washing the pulp with hot water to remove soluble tannins reduced the amount of affixing chemical needed to set the size from 6 to 2%, moisture-free pulp basis. The flexural strength, however, of the hardboards prepared with 6% of affixing chemical was appreciably higher than that of boards prepared with 2%. Some of the hardboards prepared were of class A grade.

WHITE oak has not been used to any great extent in the pulp and paper industry, though it has been available in large amounts, especially on farm woodlots, in the United States east of the Mississippi River. Its use in this industry is mostly in printing papers and corrugating board. This report presents data on the preparation of hardboard from low-grade white oak. The hardboards were prepared from defibrator stock and were of the conventional screen-back (wet-formed) type.

MATERIALS

Wood

The white oak used came from eastern Virginia. Its average density was 38.4 lb. per cu. ft.; diameter, 5.4 in.; age, 41 yr.; and rate of growth, 15.2 rings per in. The wood contained 53% of heartwood.

The wood was barked and then converted into $^5/_8$-in. chips with a chipper. The moisture content of the chips was about 27%; consequently, they were not soaked before fiberizing.

Sizing Chemicals

The following chemicals were used in sizing: (1) rosin size, a completely water-soluble material of commercial manufacture; (2) paraffin size, an oil-in-water emulsion made in the laboratory; (3) papermaker's alum, $Al_2(SO_4)_3 \cdot 18H_2O$; (4) ferric sulphate, $Fe_2(SO_4)_3 \cdot 6H_2O$; and (5) sulphuric acid. Each was made up in 10% solutions (by weight) before use.

The laboratory-prepared paraffin wax size consisted of: paraffin, 100 grams; oleic acid, 20 grams; concentrated ammonium hydroxide, 5 grams; and sufficient distilled water to make 1 liter of emulsion. The method of preparation follows: (1) the paraffin, melted and mixed with oleic acid, was heated to 80°C.; (2) the ammonium hydroxide and then the paraffin mixture were added in rapid succession to 250 ml. of water at 80°C.; and (3) the emulsion was vigorously stirred and cooled at the same time. When diluted to 1 liter, the emulsion contained 10% of paraffin by weight.

EQUIPMENT AND PROCEDURE

Fiberization

The white oak chips were fiberized in the stainless steel, laboratory-model Asplund defibrator shown in Fig. 1. The defibrator consists of a $2^3/_4$-gal. cylinder fitted with an axial shaft from which protrude four steel blades. These blades extend radially to within about one-eighth of an inch of the cylinder wall, but only about ten one-thousandths of an inch from any of the five equally spaced longitudinal steel bedplates. The edges of the blades are beveled to the contour of the cylinder, and the shaft is rotated in the clockwise direction, which produces a brushing action. The chip charge is approximately 1 lb., moisture-free basis.

Many defibration runs were necessary to secure a sufficient amount of pulp for this investigation. In each run the charge of chips was presteamed and then milled at the same steam pressure. Every run was terminated by shutting off the steam and the motor of the defibrator. The steam in the cylinder was relieved to the cyclone. After the cylinder cover was unbolted and removed, the pulp was washed into a screen box, and the pulp that had been blown into the cyclone was added to it. The combined pulp from a batch of four or five runs was washed with cold water and pressed to about 70% moisture content. Yield determinations were made by weighing the pulps of one or more batches and determining their moisture content. The conditions of defibration, pulp yield, and pulp-freeness data are given in Table I.

Pulp Refining

The defibrator pulps were refined in an 8-in., single-rotating-disk mill fitted with beveled, radial-serrated plates (Fig. 2). In the refining procedure, the pulp was fed to the mill with relatively large amounts of water. The plate clearance was in excess of 0.10 in., and the resultant processing action was a mild brushing action. The refined pulp was caught in an 80-mesh screen box.

Stock Freeness

For determining the freeness of the stocks, a defibrator tester (Fig. 3) was used. The value obtained with this apparatus is the drainage time, in seconds, required for the water in a 10-liter sample of fiber suspension (128 grams per 10 liters) to pass through a screen and

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for 10 liters of air to pass through the pulp mat formed on the screen.

Mat Preparation and Sizing

The pulp for hardboard preparation was dispersed in softened water at a consistency of 2.0%. All pulp mats were formed in the defibrator freeness tester.

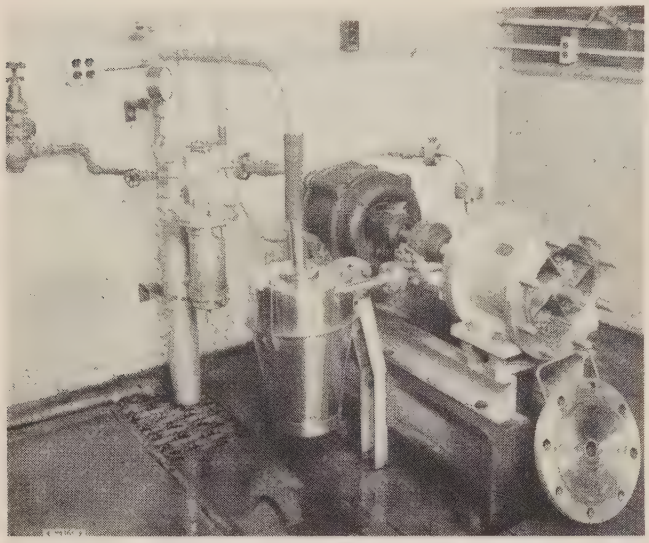

Fig. 1. A laboratory-model, stainless steel Asplund defibrator

After two unsized mats were prepared from each stock, the remainder of the stock was sized. Rosin or paraffin size was used in amounts ranging from 0.25 to 1.0%, moisture-free pulp basis. The size was affixed to the fibers by the addition of 0.25 to 9.0% of alum or ferric sulphate. When required, sufficient 10% solution of sulphuric acid was added to lower the pH to a range of 4.0 to 4.5. If large amounts of ferric sulphate were used, the addition of acid was unnecessary because the pH of the stock was generally lower than desired.

Table I. Yields of Pulp from Low-Grade White Oak and Other Woods Fiberized in a Laboratory-Model Asplund Defibrator

Species	*Defibrator run No.*	*Pulp yield, %*	*Freeness (defibrator), sec.*	*Yield in excess of that of white oak, %*
5-Min. Defibration Run[a]				
White oak	50D	75.3	34	..
Soft maple	13D	86.6	27	11.3
Beech	14D	86.1	23	10.8
White birch	15D	81.8	24	6.5
Hard maple	16D	85.8	27	10.5
White fir	22D	87.0	..	11.7
European beech	34D	84.0	24	8.7
Southern yellow pine	38D	85.2	13	9.9
Sweetgum	40D	86.8	18	11.5
Red oak	41D	82.9	29	7.6
Cypress	42D	88.8	12	13.5
Sand hickory	51D	89.2	18	13.9
Av.				10.5
3-Min. Defibration Run[b]				
White oak	53D	81.7	22	..
Soft maple	46D	91.0	..	9.3
Beech	47D	92.2	..	10.5
White birch	48D	87.6	..	5.9
Hard maple	49D	91.7	..	10.0
Av.				8.9

[a] 3-min. presteaming period; 2-min milling period. Steam pressure, 175 p.s.i.
[b] 2-min. presteaming period; 1-min. milling period. Steam pressure, 175 p.s.i.

Pressing

Nominal $^1/_8$-in. screen-back hardboards were made from both unrefined and refined stocks. For each condition investigated, duplicate pulp mats were cold pressed to remove excess water and then hot pressed at temperatures ranging from 180 to 240°C. for 10 min. at a maximum pressure of 500 p.s.i.

The pressing schedules for these boards are given in Table II. The total pressing time was 10 min., including the initial period at maximum pressure, the breathing period at a pressure of 100 p.s.i., and the final period at maximum pressure.

Test Methods

The hardboards were tested for modulus of rupture and water absorption. Each board furnished three 5 by 2-in. test specimens, two for strength tests and one for water-absorption tests. These tests were made according to Forest Products Laboratory procedure (*1*), except that the water-absorption specimens were smaller than those specified and that the water-absorption results were reported on a percentage weight-increase basis rather than on a volume-increase basis. Exploratory determinations on nominal $^1/_8$-in. hardboard showed that the specimens used gave water-absorption results comparable to those given by the larger samples (12 by 12 in.) required by the test specifications. The thickness of the samples was determined both before and after soaking and the increase in thickness reported.

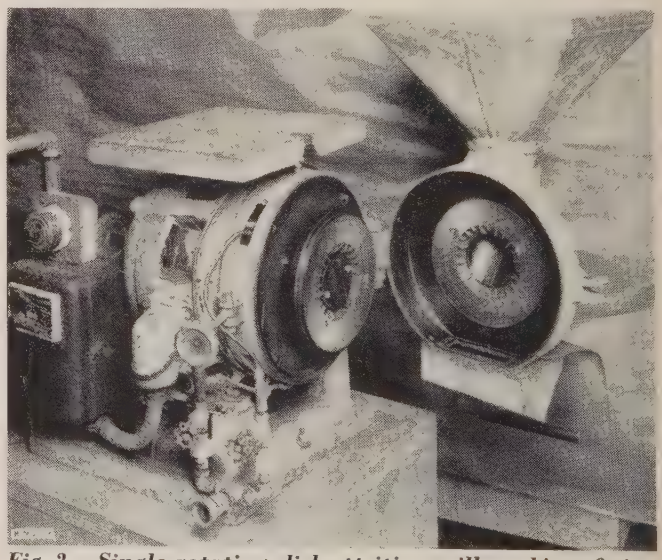

Fig. 2. Single-rotating-disk attrition mill used in refining Asplund stock

Certain series of boards were tested for toughness. Each of these boards furnished two 5 by $^1/_2$-in. specimens that were tested on the Forest Products Laboratory intermediate-capacity toughness-testing machine. This machine, originally designed for testing wood, is a pendulum type and, as adapted for these tests, measures the energy required to break a $^1/_8$ by $^1/_2$-in. unnotched specimen on a span of $2^1/_2$ in.

DISCUSSION OF RESULTS

Defibrator Pulp Yields

The yields of defibrator pulps obtained from the white oak were low. The average yield of pulp obtained from other woods (Table I) under comparable conditions exceeds that of white oak by approximately 10%. The hydrolytic or solubilizing effect of water at elevated temperatures on the components of wood has been investigated (*1*, *8*). Even with this information, however, proximate wood analyses are not always indicative of the comparative yields of pulps obtainable from various woods (*4*, *8*); hence, it is not likely that the low yields of defibrator pulps from white oak could be anticipated from such analyses.

White oak chips presteamed for 3 min. and then milled for 2 min. at a pressure of 175 p.s.i. yielded 75.3% of pulp. The low yield and the relatively high defibrator freeness—34 sec.—of this unrefined pulp (run no. 50D), plus difficulties encountered in attempting to convert this pulp to class A hardboard (*2*), led to the preparation, and a more thorough evaluation, of a higher yield and freer pulp (run no. 53D).

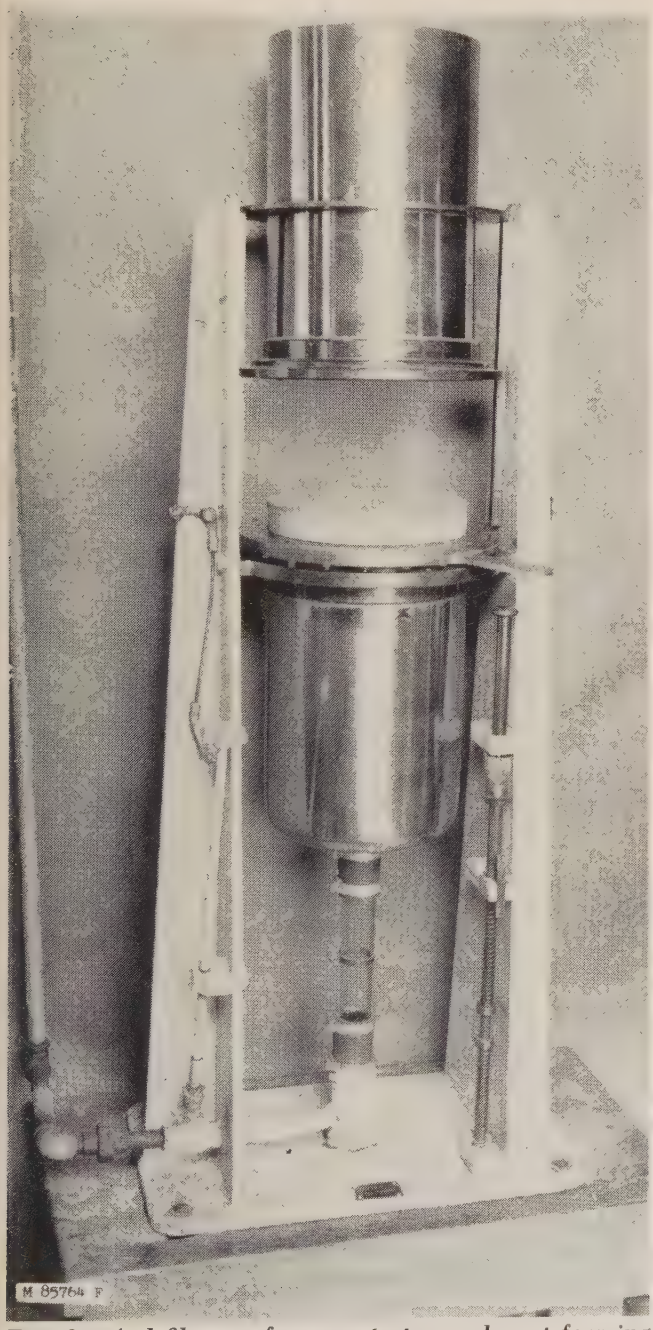

Fig. 3. A defibrator freeness tester and mat-forming machine

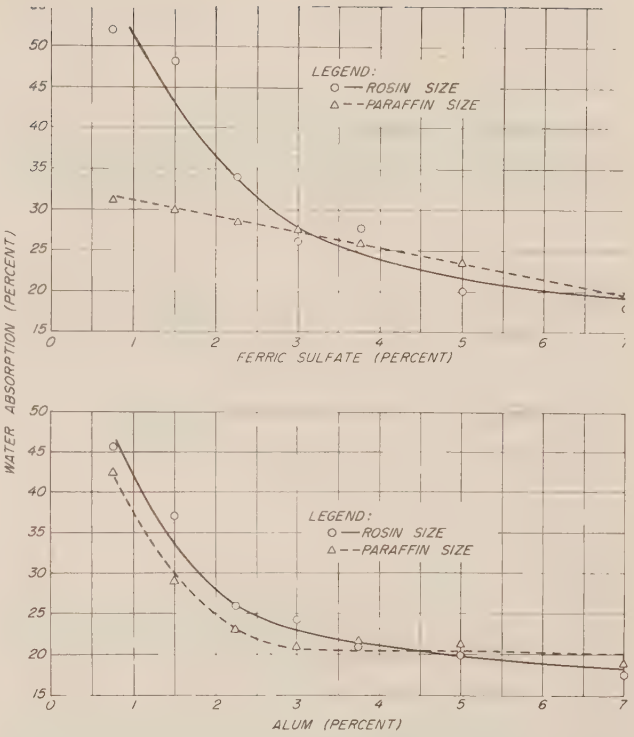

Fig. 4. The effect of varying the amount of size-affixing chemical on the water absorption of hardboards made from unrefined, white oak defibrator pulp (run no. 53D). The boards contained 0.75% of size and were molded at 195°C.

The differences between the two pulps, other than freeness and yield, were of no great significance in this investigation. Of paramount importance, however, was the fact that doubling the ratio of alum or ferric sulphate to size had a pronounced beneficial effect on the water resistance of the hardboard produced from either pulp (Table II) whether the amount of size was 0.75 or 1.5%. In this respect white oak hardboard differs from hardboard made from beech, white birch, hard and soft maple (*7*), and, undoubtedly, many other woods.

Hardboard no. 1328 produced from the higher yield pulp and molded at 240°C. met class A specifications.

Amount of Size-Affixing Chemical

Refining does not markedly influence sizing efficiency (*7*); hence, sizing experiments were made with unrefined pulp. Batches of this pulp were sized with 0.75% of rosin or paraffin, and the size was affixed with varying amounts of alum or ferric sulphate. The amounts of sizing chemicals were calculated on a moisture-free pulp basis.

The data (Fig. 4) show that, with either rosin or paraffin size, the amount of affixing chemical—alum or ferric sulphate—required to set the size was greatly in excess of the amount of size added. In all cases the most effective sizing for white oak hardboard was ob-

tained with 7% of affixing agent, almost 10 times the amount of size added.

Effect of Increasing the Alum-Size Ratio

White oak hardboards sized with 1% of rosin were greatly improved in water resistance and flexural strength by increasing the alum-size ratio (Fig. 5).

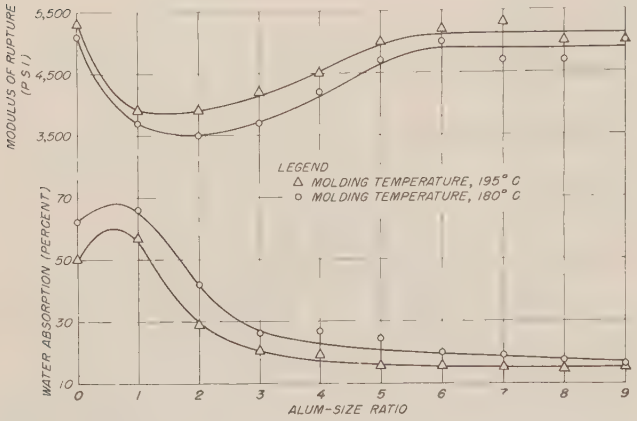

Fig. 5. The effect of increasing the alum-size ratio on the flexural strength and water absorption of hardboards made from white oak defibrator pulp (run no. 53D) with a freeness of 34 to 36 sec. The boards contained 1% of rosin size. Modulus of rupture values are adjusted to a specific gravity basis of 1.0

The hardboards were prepared from pulp mildly refined to a defibrator freeness of 34 to 36 sec.

Increasing the alum-size ratio from 1:1 to 6:1 decreased the water-absorption values from 66 to 20%, and from 57 to 15% for boards molded at platen temperatures of 180 and 195°C., respectively. The

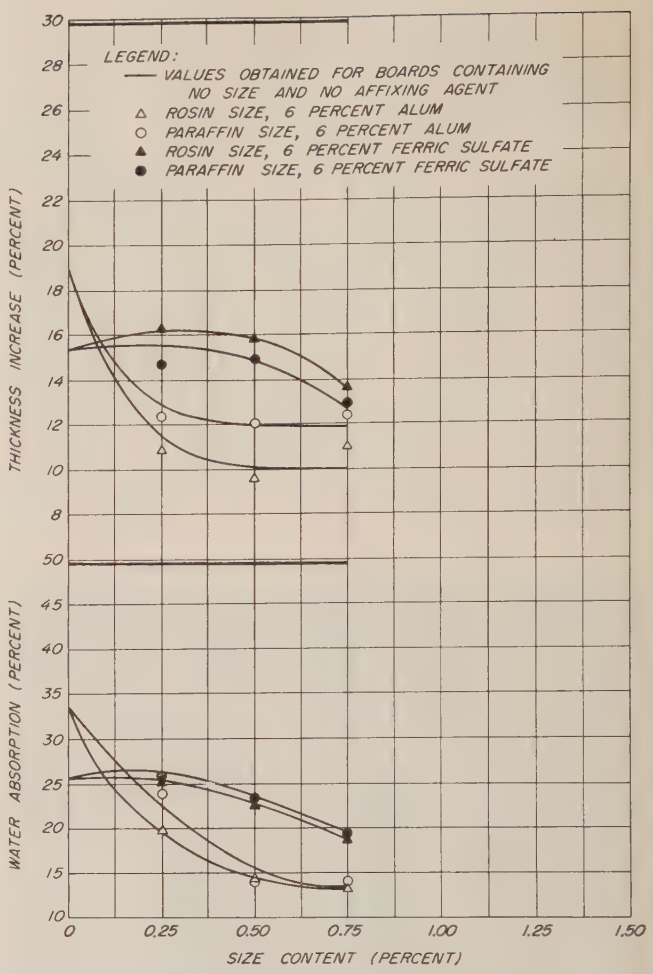

Fig. 6. The effect of the type and amount of size on the water absorption and thickness increase (after soaking) of hardboards made from white oak defibrator pulp (run no. 53D) with a freeness of 47 sec. The boards were molded at 195°C.

Table II. Preliminary Evaluation of Hardboards Prepared from Stocks Obtained in Two Different Defibrator Runs

Board No.	Defibrator run No.[a]	Refined stock	Sizing data[b] Rosin, %	Alum, %	Ferric sulphate, %	pH	Freeness (defibrator), sec.	Molding data[c] Temperature, °C.	Schedule,[d] min.	Board data: Specific gravity	Modulus of rupture, Original, p.s.i.	Modulus of rupture, Adjusted[e] p.s.i.	Water absorption, %	Thickness increase,[f] %
1305	50D	No	0	0	0	7.6	34	180	2-1-7	1.07	5700	5000	50	30
1314	53D	No	0	0	0	7.7	22	180	2-1-7	1.04	5700	5300	67	50
1316	53D	No[g]	0	0	0	7.5	23	195	2-1-7	1.02	5550	5300	57	35
1311	50D	No	0	0	0	7.2	37	240	1-2-7	1.07	7530	6600	28	12
1315	53D	No	0	0	0	7.7	24	240	1-2-7	1.02	6640	6400	31	14
1317	53D	No[g]	0	0	0	7.5	24	240	1-2-7	1.01	6140	6000	30	15
1325	53D	Yes	0	0	0	7.9	38	240	1-2-7	1.07	8150	7100	31	15
1306	50D	Yes	1.5	1.5	0	4.2	53	180	2-1-7	1.06	4540	4000	42	25
1307	50D	Yes	1.5	3.0	0	4.2	55	180	2-1-7	1.06	4850	4300	16	13
1308	50D	Yes	1.5	0	1.5	4.1	64	180	2-1-7	1.05	5120	4600	28	18
1302	50D	No	1.5	0	3.0	4.2	33	180	2-1-7	1.07	4120	3600	21	17
1318	53D	No[g]	0.75	0.75	0	4.3	25	195	2-1-7	0.98	3580	3700	64	41
1326	53D	Yes	0.75	1.5	0	4.4	39	195	2-1-7	..	..	..	37	29
1320	53D	No[g]	0.75	0	0.75	4.4	23	195	2-1-7	1.01	4460	4400	64	38
1333	53D	Yes	0.75	0	1.50	4.2	38	195	2-1-7	..	..	..	37	25
1312	50D	No	0.75	1.5	0	4.2	33	240	1-2-7	1.08	5800	5000	17	10
1313	50D	No	1.5	1.5	0	4.1	37	240	1-2-7	1.04	4700	4300	21	11
1319	53D	No[g]	0.75	0.75	0	4.3	26	240	1-2-7	0.99	4820	4900	25	13
1328	53D	Yes	0.75	1.5	0	4.4	46	240	1-2-7	1.04	6030	5600	19	12

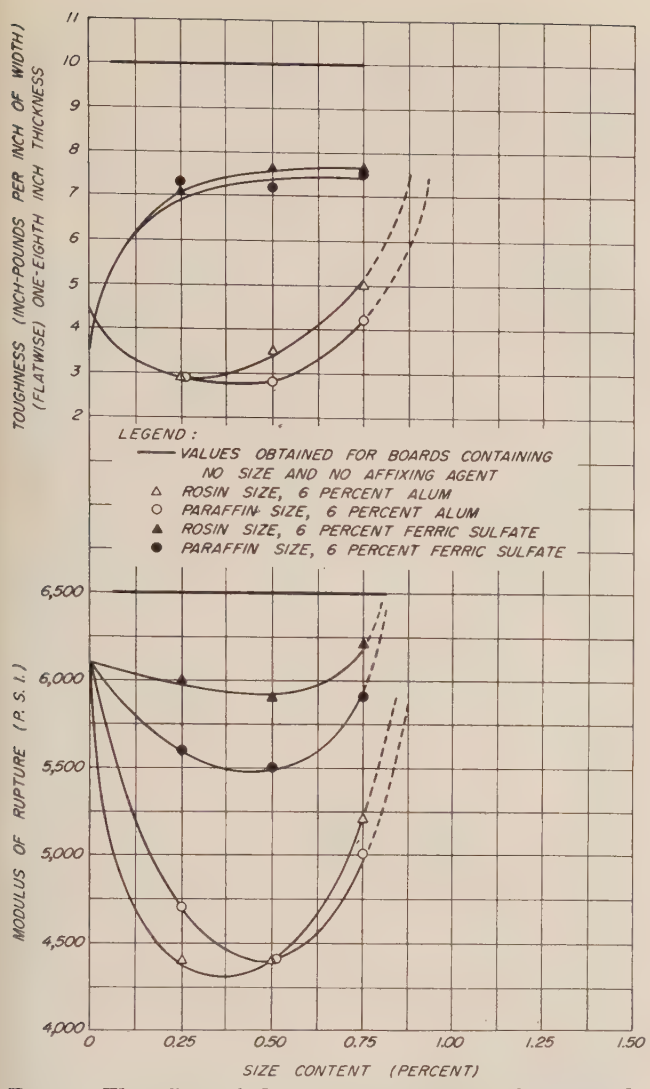
TOUGHNESS (INCH-POUNDS PER INCH OF WIDTH) (FLATWISE) ONE-EIGHTH INCH THICKNESS
LEGEND :
VALUES OBTAINED FOR BOARDS CONTAINING NO SIZE AND NO AFFIXING AGENT
ROSIN SIZE, 6 PERCENT ALUM
PARAFFIN SIZE, 6 PERCENT ALUM
ROSIN SIZE, 6 PERCENT FERRIC SULFATE
PARAFFIN SIZE, 6 PERCENT FERRIC SULFATE
MODULUS OF RUPTURE (P.S.I.)
SIZE CONTENT (PERCENT)

Fig. 7. The effect of the type and amount of size on the toughness and flexural strength of hardboards made from white oak defibrator pulp (run no. 53D) with a freeness of 47 sec. The boards were molded at 195°C. Modulus of rupture values are adjusted to a specific gravity basis of 1.0

flexural strength values of these boards rose from 3700 to 4900 p.s.i. at 180°C. and from 3900 to 5100 p.s.i. at 195°C. With higher alum-size ratios; the flexural strength of hardboards prepared at either molding temperature and the water resistance of the boards molded

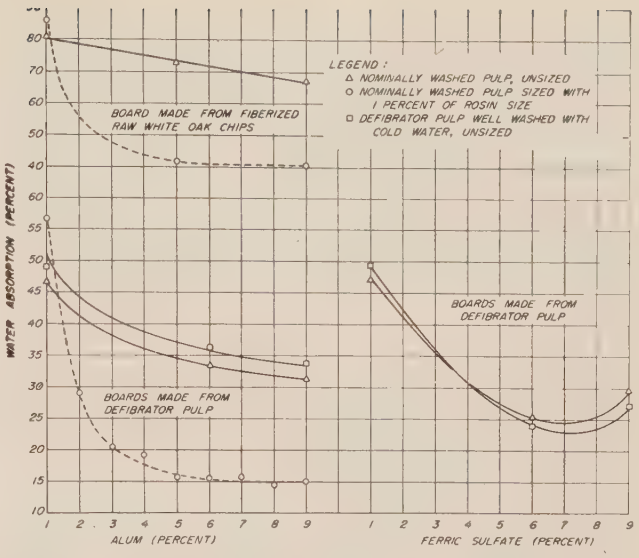
LEGEND :
NOMINALLY WASHED PULP, UNSIZED
NOMINALLY WASHED PULP SIZED WITH 1 PERCENT OF ROSIN SIZE
DEFIBRATOR PULP WELL WASHED WITH COLD WATER, UNSIZED
BOARD MADE FROM FIBERIZED RAW WHITE OAK CHIPS
BOARDS MADE FROM DEFIBRATOR PULP
BOARDS MADE FROM DEFIBRATOR PULP
WATER ABSORPTION (PERCENT)
ALUM (PERCENT)
FERRIC SULFATE (PERCENT)

Fig. 8. The effect of the amount of size-affixing chemica on the water absorption of hardboards made from fiber ized raw white oak chips and from white oak defibrato pulp (run no. 53D). The boards were molded at 195°C

at 195°C. showed no further improvement. Increasing the alum-size ratio from 6:1 to 9:1, however, decreased the water-absorption values of the hardboards molded at 180°C. from 20 to 16%. Thus, hardboards prepared at 180 and 195°C. did not vary greatly from one another in strength and water resistance when the alum-size ratio was in excess of 6:1.

Effect of Type and Amount of Size

The type and amount of size, as well as the type and amount of affixing agent, significantly influenced the properties of white oak hardboards (Figs. 6 and 7).

Hardboards prepared from stocks refined to a defibrator freeness of 36 sec. and sized with 1% of rosin did not meet the class A strength specification of 6000 p.s.i. for modulus of rupture (Fig. 5). Further refining of the pulp, the addition of less size, the substitution of ferric sulphate for alum, or all three means were indicated as ways of securing higher strength boards. Consequently, hardboards were prepared containing 0 to 0.75% of size—rosin or paraffin—and 6% of affixing

Table III. Properties of White Oak Hardboards Made from Nominally Washed and Well-Washed Defibrator Pulps[a]

Board No.	Stock	Sizing data[b]					Freeness (defibrator), sec.	Board data[c]			
		Rosin, %	Paraffin, %	Alum, %	Ferric sulphate, %	pH		Specific gravity	Adjusted modulus of rupture,[d] p.s.i.	Water absorption, %	Thickness increase,[e] %
1484	Well washed	0	0	0	0	7.6	40	1.04	6100	47.5	30.7
1498	Nominally washed	0	0	0	0	7.5	43	1.03	6200	49.2	28.9
1485	Well washed	0.75	0	6.0	0	4.3	41	1.04	4700	13.7	11.7
1499	Nominally washed	0.75	0	6.0	0	4.3	44	1.02	5000	13.4	11.0
1486	Well washed	0.75	0	0	6.0	3.2	45	1.05	5600	16.3	13.0
1500	Nominally washed	0.75	0	0	6.0	3.3	47	1.03	5900	18.7	13.0
1487	Well washed	0	0.75	6.0	0	4.3	41	1.05	4800	14.7	12.9
1501	Nominally washed	0	0.75	6.0	0	4.2	43	1.02	4800	13.7	10.5
1488	Well washed	0	0.75	0	6.0	3.3	45	1.06	5200	18.0	14.1
1502	Nominally washed	0	0.75	0	6.0	3.2	41	1.03	5600	19.1	13.6

[a] The pulp was from defibrator run no. 53D. The nominally washed pulp was washed with cold tap water, pressed, refined, and drained before the boardmaking operations. The well-washed pulp was washed with cold tap water, pressed, refined, and drained; dispersed and agitated in cold softened water and drained; and then thoroughly mixed with some freshly refined pulp in cold softened water and drained before boardmaking operations.

[b] Stock sized at approximately 2% consistency.

[c] Boards molded at 195°C. for 10 min.: maximum pressure, 500 p.s.i.; minimum pressure, 100 p.s.i. Molding schedule: 2 min. at maximum pressure, 1-min. breathing period at minimum pressure, 7 min. at maximum pressure.

[d] Adjusted to a specific gravity of 1.0 on the basis that the modulus of rupture varies as the square of the specific gravity.

[e] Determined by measurements before and after soaking.

agent. Four series of boards were prepared from stocks refined to a defibrator freeness range of 40 to 47 sec. The flexural strength values of these hardboards in some instances were adjusted slightly to place these data on a 47-sec. freeness basis.

The data, when compared with the intrinsic qualities of the stocks as indicated by the properties of the unsized boards, disclosed that the addition of alum or ferric sulphate alone brought about a slight reduction in

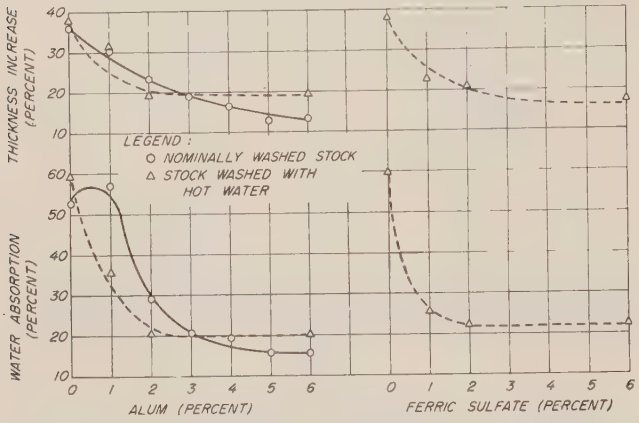

Fig. 9. A comparison of the water absorption and thickness increase (after soaking) of white oak hardboards made from stock washed with hot water to extract the soluble tannins and from nominally washed stock. The pulp used was from defibrator run no. 53D and had a freeness of 36 sec. The boards were molded at 195°C.

flexural strength, a marked reduction in toughness, a decided improvement in water resistance, and a decided decrease in thickness change. Increasing the size content from 0 to 0.75% decreased both the water absorption and thickness change of the boards. Boards containing alum were superior to those containing ferric sulphate in this respect, but in all cases 0.75% of size or less was sufficient to bring the water-absorption values below class A hardboard specifications. From the trend of the data (Fig. 6), it does not appear that increasing the size content beyond 0.75% will much improve water resistance.

The strength properties of the hardboards did not follow the anticipated trend; board strength was lower rather than higher when less size was added. All four types of boards gave minimum flexural strength values at a size content of 0.25 to 0.50%. In all cases higher flexural strength values were obtained from boards containing 0.75% of size. The data shown in Fig. 7 indicate that maximum flexural strength values obtainable from sized boards would be in the range of 0.75 to 1.0% of size.

Toughness values of the boards containing alum were at a minimum of about 3 in.-lb. per in. of width at a range of 0.25 to 0.50% of size and were highest at 0.75% of size. The trend of the data indicates maximum toughness values for sized boards in the range of 0.75 to 1.0% of size. The boards containing ferric sulphate reached a high toughness value of about 7 to 7½ in.-lb per in. of width at 0.25% of size, which remained constant with increasing amount of size.

Hardboards containing 0.75% of size and 6.0% of ferric sulphate met class A hardboard specifications. The rosin-sized board of this group met class A flexural strength requirements even when this value was reduced to a specific gravity basis of 1.0, as shown in Fig. 7. The ferric sulphate boards were brown black to black in color and the corresponding alum-size boards were tan.

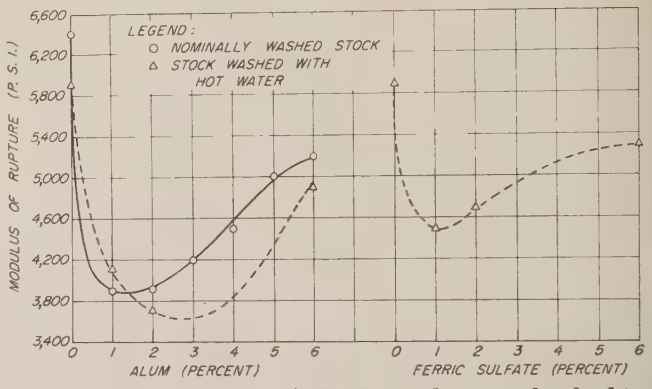

Fig. 10. A comparison of the flexural strength of white oak hardboards made from stock washed with hot water to extract the soluble tannins and from nominally washed stock. The pulp used was from defibrator run no. 53D and had a freeness of 36 sec. The boards were molded at 195°C. Modulus of rupture values are adjusted to a specific gravity basis of 1.0

Table IV. Reaction of Sulphuric Acid, Alum, and Ferric Sulphate with the Cold-Water Extracts of Fiberized Chips and of Defibrator Pulp from White Oak

Extract			Precipitate		Color of supernatant liquid	Color of wet mat	Color of hardboard[a]
Type	Color	Reagent	Color	Type			
Fiberized chips	Reddish-brown	.....	.....	.....	.....	Cream	Tan
Fiberized chips	Reddish-brown	Dilute sulphuric acid	Light brown	Flocculent	Light yellow	.....	.....
Fiberized chips	Reddish-brown	Aqueous alum	Brown	Flocculent	Light brown	Cream	Cream
Fiberized chips	Reddish-brown	Aqueous ferric sulphate	Blue-black	Flocculent	Light greenish-yellow	Light gray-blue	Light gray
Defibrator pulp	Deep reddish brown	.....	.....	.....	.....	Brown	Mottled brown
Defibrator pulp	Deep reddish brown	Dilute sulphuric acid	Light brown	Flocculent	Light yellow	.....	.....
Defibrator pulp	Deep reddish brown	Aqueous alum	Brown	Flocculent	Light brown	Brown	Brown[b]
Defibrator pulp	Deep reddish brown	Aqueous ferric sulphate	Blue-black	Flocculent	Light greenish-yellow	Dark gray	Very dark gray-brown

[a] Color of sized hardboards similar to those obtained with affixing chemical alone.
[b] The color of the board deepens with increasing amounts of alum.

The peculiarities encountered in the preparation of hardboard from white oak can undoubtedly be attributed to tannins or tanninlike substances. The presence of tannins in white oak as well as its bark is well known (*1, 3, 4, 5, 8*).

As mentioned previously, the oak defibrator pulps absorbed unusually large amounts of size-affixing chemicals. Pulps prepared by fiberizing raw white oak chips in a small attrition mill reacted similarly to those prepared in the defibrator. Furthermore, prolonged washing of the defibrator pulp with cold water had but little effect on the affixing chemical requirement of the pulp and the properties of the resultant hardboards. From these facts it could be concluded that white oak wood contains minor components that readily react with alum and ferric sulphate; that these materials are not readily soluble in cold water; and that they are present in both the wood and the pulp. The data supporting these observations are given in Fig. 8 and Table III.

The amounts of tannins or tanninlike substances in the oak wood and its pulps were not quantitatively determined; sufficient qualitative data, however, were obtained to confirm their presence. Water extracts expressed from both the fiberized wood chips and the defibrator pulp mats were, respectively, brown and reddish-brown solutions and gave qualitative reactions similar to those of aqueous solutions of tannins in general and several reactions specifically those of phlobotannins (*5*). These solutions were obtained by cold pressing unsized pulp mats that had been allowed to stand for 16 to 20 hr. before this operation. On the other hand, the excess water removed from any of the sized mats was clear and practically colorless, because the alum, ferric sulphate, and sulphuric acid precipitate the tannins within the pulp fibers. The reaction effects of sulphuric acid, alum, and ferric sulphate with the cold-water extractives of the fiberized raw wood and the defibrator pulp and on the color of the pulp mats and resultant hardboards are given in Table IV.

An attempt was made to extract the tannins or tanninlike substances from the defibrator pulp with water at 95°C. Batches of pulp, each approximately 4 lb. on a moisture-free basis, were enclosed in tightly woven lightweight cotton bags and immersed in an overflowing bath of water at 95°C. The water was continuously heated and agitated by live steam until the overflow was clear. The extractives, copious at first, colored the water brown, and samples of these washings gave a blue color test with aqueous ferric chloride. The washed pulp was pressed, wetted with hot water, and repressed. This procedure was repeated until the expressed water ran clear. The resultant pulp was considerably lighter in color than the original. The amount of solubles removed was 7.8%.

The hot water, however, apparently did not remove all of the tannins or tanninlike materials from the pulp because ferric sulphate turned the washed pulp gray. The resultant hardboards were also gray-brown, although considerably lighter colored than comparable boards made from the original pulp. The amount of affixing chemical necessary to set the size was reduced from 6 to 2% by this washing operation (Fig. 9).

The flexural strength, however, of the hardboards prepared from the pulp washed with hot water followed the same trend as those prepared from the nominally washed pulp. As shown in Fig. 10, the flexural strength of the boards prepared with 6% of affixing chemical was appreciably higher than that of boards prepared with 2%.

The presence of residual tannins in the washed pulp may be attributed to insoluble condensation products, phlobaphenes, resulting from the treatment in the defibrator.

CONCLUSIONS

The behavior of white oak defibrator pulp prepared for hardboard stock is radically different from that of similar pulps made from several other hardwoods. The oak pulp requires disproportionately large amounts of size-affixing chemical—alum or ferric sulphate. For beech, white birch, and hard and soft maple pulps, a ratio of affixing chemical to size of 1:1 is sufficient; for the oak pulp, however, a ratio of at least 6:1 is necessary. The flexural strength of the oak hardboards, as well as the water resistance, is influenced by the ratio of affixing chemical to size. Maximum strength is obtained at a ratio of 6:1 or higher. Furthermore, the amount of size, either rosin or paraffin, required to secure hardboards of optimum flexural strength appears to lie in the range of 0.75 to 1.0%. Lower amounts of size, though adequate to impart water resistance to the boards, bring about lower flexural strength.

The peculiarities of the white oak pulp, to a great extent, may be attributed to polymerized tannins and tanninlike substances, which are not extractable with water. Washing the pulp with hot water reduces the amount of affixing agent necessary to set the size from 6 to 2%, moisture-free pulp basis. In spite of the removal of considerable portions of tannins or tanninlike components, however, the pulp becomes gray upon the addition of ferric sulphate, and the flexural strength of the hardboards prepared with 6% of affixing chemical is appreciably higher than that of boards prepared with 2%.

Class A hardboard can be made from white oak if these peculiarities are recognized and adequate adjustments in procedure made therefor.

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The Isolation of Holocellulose from Wood

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The analytical preparation of holocellulose from black spruce by the chlorine-monoethanolamine method results in less carbohydrate loss than that occurring in the isolation of chlorite holocellulose. If partially chlorited products are further delignified by chlorine-monoethanolamine treatments, the carbohydrate loss is much greater than that occurring when either method is used alone. The amount of acid-soluble lignin in the various delignified products was estimated through ultraviolet absorbance measurements on the lignin filtrates. Acid-soluble lignin was present in all the delignified products, and it was particularly high in the woods partly delignified by acidified chlorite. Although the presence of sugar decomposition products leads to enhanced values of soluble lignin, the essential correctness of the soluble lignin was established from methoxyl data and from summative analyses which included total reducing sugars. All the delignified products contained considerable chlorine, and those treated with monoethanolamine contained nitrogen. A part of the apparent increase in uronic acid content which occurs in the course of delignification may be caused by oxidized lignin products which yield carbon dioxide during the decarboxylation reaction.

THE isolation of cellulose preparations from wood by delignification with suitable reagents has been carried out for nearly a century (cf. (*1*), esp. Chapter 29). In the early work, the differentiation between the substances now designated "cellulose" and "hemicelluloses" was not clearly recognized, and part of the hemicelluloses were included in the cellulose preparations. In addition, many of the methods used were of such a nature that extensive hydrolysis and oxidation of the cellulose occurred. As a result, the "cellulose" preparations obtained were of a heterogeneous character, and little significance could be attached to analytical figures.

As the chemistry of cellulose and of its associated polysaccharides has been clarified within recent years, it has become evident that the earlier methods for determination of "cellulose" by isolation of "cellulose preparations" represent a confusion of terms which, unfortunately, has been partially perpetuated to the present day. The precise determination of "cellulose" in wood as established by a rigorous definition is a goal yet to be attained.

In the past, the delignification of wood for analytical purposes has been aimed at the preparation of empirically defined polysaccharide fractions such as Cross and Bevan cellulose, or it has been directed toward producing a fraction representing essentially all the polysaccharide materials present in the original wood. Procedures of the latter type are represented by the holocellulose methods, e.g., the chlorine-monoethanolamine procedure of Van Beckum and Ritter (*2*) and by the methods that employ acidified sodium chlorite, such as the chlorite holocellulose procedure of Wise, *et al.* (*3*).

It is generally recognized that holocellulose procedures fall short of the ideal, in that it has proved impossible in practice to completely delignify wood without at the same time losing a considerable portion of the polysaccharides. When the objective is subsequent isolation of a fraction representing relatively pure cellulose, the loss of noncellulose polysaccharides is immaterial if the cellulose itself is unaffected. The necessary experimental conditions are more rigorously limited if all the polysaccharides are to be retained.

The methods involving chlorination may be criticized because of possible overheating of the wood with consequent degradation and hydrolysis of the polysaccharides during the initial stages of chlorine treatment. The chloriting procedure avoids this difficulty, but it is considered that it permits a greater loss of polysaccharides as the delignification approaches completion. For analytical purposes, it might prove advantageous to utilize the best features of both methods; that is, to commence the delignification with acidified chlorite and to complete it by the chlorine-monoethanolamine procedure.*

The possible utility of this approach has been examined by preparation of a series of chlorited products, and by preparation from each of these and from the original wood of chlorine-monoethanolamine holocellulose. The analyses of the products have furnished additional information which may be useful in consideration of delignification procedures.

EXPERIMENTAL

The wood used was a pulpwood log of Canadian black spruce (*Picea mariana*), approximately 75 years old and 6 in. in diameter at the point sampled. After the log was barked and the knots were drilled out, it was converted to shavings on a power jointer. The shavings were further comminuted by passage through a Wiley mill, and the 40 to 60-mesh fraction of the wood was prepared.

All the wood meal used in the experimental work was extracted for 8 hr. with benzene in a Soxhlet extractor and then for two successive 4-hr. periods with cold water, using 10 ml. of water per gram of wood. The extracted wood was thoroughly air-dried. The unextracted wood meal contained 1.86% benzene-soluble and 2.49% cold-water-soluble material (after benzene) on the basis of the ovendry unextracted wood.

The chlorited wood were prepared by the method of Wise, *et al.* (*3*). Products A, B, and C were obtained by chloriting for 1, 2, and 4 hr. with one, three, and four chlorite additions, respectively. Chlorine-monoethanolamine holocelluloses were prepared from the

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* This suggestion was developed in part through discussion with G. J. Ritter, to whom acknowledgment is made.

Table I. Yield and Lignin Content

Percentage of extracted wood

	A	*B*	*C*	*D*	*E*	*F*	*G*
	Yield	*Lignin*	*Soluble lignin*	*Yield, cor. for lignin (A–B)*	*Yield, cor. for lignin and sol. lignin [A − (B + C)]*	*Yield, cor. for lignin plus 27.68*	*Yield, cor. for lignin and sol. lignin plus 28.57*[a]
Extracted wood	(100.00)	27.68	0.89	72.32	71.43	100.00	100.00
Chlorited wood							
A	94.20	15.92	8.06	78.28	70.22	105.96	98.79
B	85.12	6.38	9.22	78.74	69.52	106.42	98.09
C	76.30	2.30	7.20	74.00	66.80	101.68	95.37
Holocellulose[b] from:							
Extracted wood	74.16	0.31	4.06	73.85	69.79	101.53	98.36
Chlorited wood							
A	67.82	0.08	3.78	67.74	63.96	95.42	92.53
B	64.28	0.05	2.24	64.23	61.99	91.91	90.56
C	57.26	None	1.86	57.26	55.40	84.94	83.97

[a] The sum of lignin and soluble lignin in extracted wood.
[b] By chlorine-monoethanolamine method.

extracted wood and from the three chlorited wood samples. The method in general followed TAPPI Standard T 9 m-51, except that the chlorinations and extractions were carried out in a 100-mm. fritted glass Buchner funnel. During chlorination the funnel was stopped at the bottom, immersed in an ice bath, and the chlorine was introduced above the wood.

The yields of products are given in Table I. Because these products contain lignin to varying degrees, it is necessary to correct for the lignin content. The yield corrected for lignin should represent "holocellulose," e.g., the original extracted wood less the lignin, and should be identical for the various preparations if no loss of polysaccharides occurred during delignification.

Lignin is commonly determined by the Klason 72% sulphuric acid method, or by similar methods based on hydrolysis of the polysaccharides by strong mineral acids. That these methods are inadequate in defining the content of total material which is usually accepted as "lignin" has been known for some time. A serious limitation arises from the considerable quantity of lignin or ligninlike material which may appear in the acid filtrate.

In application of the sulphuric acid method to woods, it has been observed for many years that additional material similar to the insoluble lignin may precipitate from the acid filtrate upon standing. More recently, the isolation of 7.4% acid-soluble lignin in beech and 5.8% in sprucewood was reported by Campbell and McDonald (*4*) and McDonald (*5*) calculated that extractive-free beechwood contained 7.5% acid-soluble lignin on the basis of ultraviolet absorbance. Wacek and Schroth (*6*) reported isolation of 5.5% acid-soluble lignin from spruce.

In wood pulps, the lignin may be altered by the pulping operation. The presence of acid-soluble lignin in pulps and the estimation of the lignin through ultraviolet absorbance measurements has been considered in the work of Trucano (*7*), Løschbrandt (*8*), Bethge, Gran, and Ohlsson (*9*), and others.

The failure of all the lignin to appear in the acid-insoluble residues is particularly serious in preparations that are fairly completely delignified, e.g., bleached pulps and laboratory cellulose preparations such as holocellulose. In these, the acid-soluble lignin may represent a large proportion of the total, and subtraction of the insoluble lignin does not provide a fair measure of total carbohydrate material in the preparation.

Campbell and McDonald (*10*) have examined chlorite holocellulose preparations from beech and sprucewood.* They found, as did Muller (*11*) and Jayme and Finck (*12*) that the sum of lignin in the wood and of holocellulose corrected for acid-insoluble lignin amounted to much over 100%, and they demonstrated that the fault lay in the presence of undetermined acid-soluble lignin in the chlorite holocellulose.

Although it is possible to make some estimate of the quantity of dissolved lignin or of soluble lignin degradation products by ultraviolet absorbance measurements on the acid lignin filtrate or other solutions, any quantitative determination is subject to two important limitations. First, although the absorptivity† can be determined reliably on purified lignin preparations, e.g., isolated native lignin, it is uncertain that the soluble lignin or lignin degradation products with which one has to deal in a specific instance have the same absorptivity. Second, absorbance in the same regions as that evidenced by lignin may result from wholly nonligneous components such as the furan-type compounds derived from the sugars.

In the present work, the acid-insoluble lignin in the wood and the isolated products was determined by the 72% sulphuric acid method (*13*) (B, Table I). Because of the expectation that considerable acid-soluble lignin would be present, it was undertaken to make an estimate of the amount from the ultraviolet absorbance at 280 mmu of the acid filtrates, with the results given in C, Table I. A value of 18.0 for absorptivity was used; this constant for unaltered lignin was confirmed in the present work by measurement on a dioxane solution of black spruce native lignin prepared by F. E. Brauns. All measurements were made with a Beckman Model DU spectrophotometer.

The compositions of the products in terms of lignin and calculated acid-soluble lignin are shown in Fig. 1. The nonlignin part of the preparation is taken to represent the polysaccharide portion which is divided into the alpha-cellulose fraction and the fraction representing, by difference, the polysaccharides not in alpha-cellulose.

The 0.89% of soluble lignin found in the extracted wood was far less than that reported by Campbell and McDonald (*4*, *5*) for sprucewood. The soluble lignin

* Most of the experimental work described herein was completed before the publications of Campbell and McDonald appeared.

† The terminology recommended by the joint committee on nomenclature (*Anal. Chem.* 24: 1349 (1952)) is used in this paper.

from redwood (pre-extracted with alcohol and hot water) amounted to 1.0% in unpublished work of the present authors. The values for soluble lignin found by Campbell and McDonald seem very high.

A very considerable amount of soluble lignin in the various delignified preparations is indicated, and the inadequacy of the Klason procedure in determining total lignin in such preparations is evident. The values found for soluble lignin are comparable to those found in chlorited products by Campbell and McDonald (*4, 10*) for equivalent degrees of delignification.

If the delignified preparations are corrected for acid-insoluble lignin only, the values for yield or yield plus lignin in wood (D and F, Table I) lead to the same improbable values reported by previous investigators. Correction for total lignin (E and G, Table I) leads to more reasonable figures, reflecting some carbohydrate loss which is the greater as delignification approaches completion.

Other evidence is necessary in assessing the reliability of the corrected yield figures, because it is possible that the analysis for soluble lignin may be in error.

The absorbance of the lignin may be altered by chloriting. Barton (*14*) found absorptivities at 280 mmμ of approximately 10 and 14 from his chlorite lignins A and B from slash pine. If the absorptivity of black spruce lignin is reduced by chloriting, then the calculated values for soluble lignin are too low. It is possible that the absorptivity of acid-soluble lignin remaining in the wood has been less changed from the original than that of a lignin product isolated from the chlorite liquor.

On the other hand, the calculated values may be too high because of carbohydrate reaction products. Unless the carbohydrates are rendered more acid-sensitive by the chloriting process, it does not seem probable that the error from this source would exceed the value of 0.9% calculated for soluble lignin in the original wood. However, it is noted later that carbohydrate products may react with insoluble lignin and be removed from solution.

The possible interference of carbohydrates may be attributed to the formation of furfural or other carbonyl compounds from carbohydrates during the acid hydrolysis. It has been shown (*15*) that these compounds absorb strongly in the region where lignin absorbances are measured. The necessity of caution in attributing ultraviolet absorbance to lignin when reaction products of sugars and acids may be present has been reemphasized recently by Kratzl and Silbernagel (*16*).

From the viewpoint only of reducing possible error introduced by carbohydrates, it might prove preferable to calculate soluble lignin from absorbance at 210 to 230 mmu. Lignin is characterized by relatively high absorption in the 210 to 230 mmu region of the ultraviolet, and by the fact that this absorption is significantly higher than at 280 mmu.

The potential contribution of sugars to the measured absorbance was estimated by ultraviolet absorbance measurements which are shown in Fig. 2. The absorptivities were calculated on the basis of total starting material in each case.

The absorbance of a sugar mixture of the same general composition as a softwood holocellulose (curve 1) is negligible. The treatment of these sugars with 72% sulphuric acid at 20° and then with boiling 3% acid as in the lignin determination yields products with an absorptivity at 280 mmu 3.8% that of native lignin, i.e., an apparent lignin content of approximately 4% is indicated (curve 2). This treatment is more severe than that of the lignin isolation, in which hydrolysis only to polyoses is accomplished in the 72% acid. However, when the sugars were treated with boiling 3% acid only, the absorptivity curve was practically identical with curve 2 in Fig. 2. Evidently any additional degradation of sugars caused by action of the 72% acid is not reflected in the appearance of substances that absorb in the ultraviolet.

It is surprising that the sugars alone give much more apparent lignin than the polysaccharides in the wood. It is possible that in analysis of the wood, the furfural and hydroxymethylfurfural formed by the boiling acid

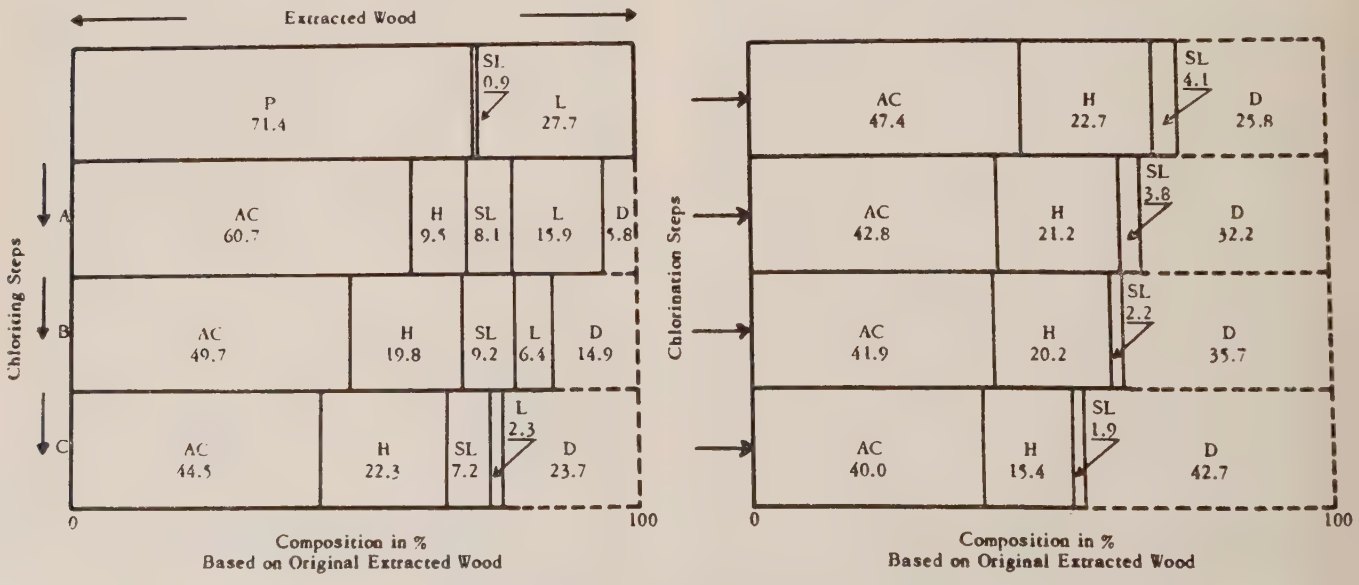

Fig. 1. The composition of delignified wood preparations

AC—Alpha-cellulose. SL –Soluble lignin. L—Lignin. P—Nonlignin portion of extracted wood. H—Polysaccharides not in alpha-cellulose (by difference). D—The material removed during delignification.

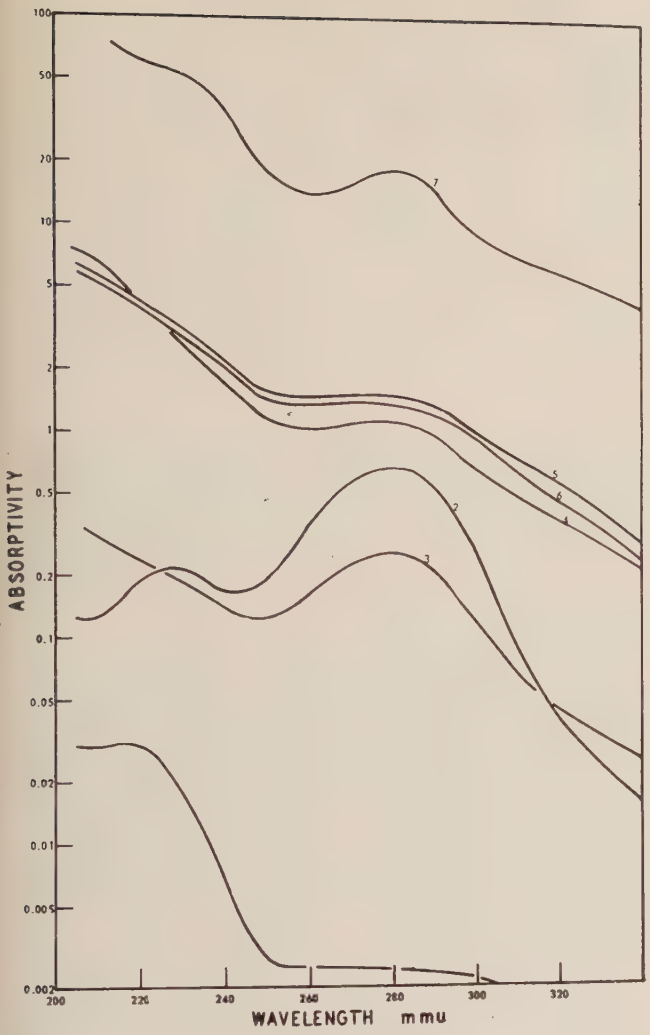

Fig. 2. Absorptivity of lignin filtrates and hydrolysis products

(1) Glucose, xylose, mannose, and glucuronolactone, in 40:10:10:4 weight ratio, in water solution. (2) The sugars as in 1, after treatment with 72% and boiling with 3% H_2SO_4 as in the lignin determination. (3) Lignin filtrate from extracted wood. (4) Lignin filtrate from chlorited wood A. (5) Lignin filtrate from chlorited wood B. (6) Lignin filtrate from chlorited wood C. (7) Black spruce native lignin in methanol.

combine with the insoluble lignin and so are removed from solution. Norman (*17*) has shown that aldehydes in considerable quantities may condense with lignin. If this occurs to the extent indicated here, the insoluble lignin would be correspondingly high.

The lignin filtrate from the wood was calculated, from the absorbance at 280 mmu, to contain 0.9% soluble lignin. It may be suspected that a considerable part of this apparent lignin arises from carbohydrate material. However, the enhanced absorptivity of the lignin filtrate at 215 mmu in comparison with that at 280 mmu suggests that some ligninlike material is present.

In order to make some correction for the absorbance contributed by carbohydrate material, the amount of soluble lignin in the lignin filtrate from the wood was recalculated. It was assumed that the absorptivity contributed by the carbohydrates in the wood was the same as that of the sugars. The total absorbance at 215 mmu was attributed to concentrations C_1 and C_2 of sugars and lignin respectively, with corresponding absorptivities of 0.15 and 70. Similarly, the absorbance at 280 mmu was attributed to the same concentrations with respective absorptivities of 0.68 and 18. Thus, there is found a value of 0.3% soluble lignin in the wood, and it appears that the carbohydrate interference in this case is considerable.

The absorptivities of the lignin filtrate from the chlorited woods indicate the presence of very considerable quantities of soluble lignin. The possible contribution of carbohydrate material to the absorbances was calculated for chlorited wood A in the manner given above. When correction for the carbohydrates is so made, the soluble lignin in chlorited wood A is found to be 7.5% as compared with the uncorrected value of 8.1% (Table I). In this instance, the relative effect of carbohydrates is less consequential.

It is evident that the reliability of lignin values derived from absorbance data depends on the absorptivity of the lignin present. The additional correction for sugar degradation products which may appear in the solution is somewhat uncertain because of the apparent removal of part of them by the insoluble lignin. A corresponding increment in the weight of lignin might be expected, although a more exact treatment is difficult without further data on the behavior and absorptivities of all the components in the system.

It has been observed in our laboratories over a considerable period of time that poor reproducibility is often found in tests for soluble lignin, whereas the precision in the same analyses for insoluble lignin may be excellent, indicating a relative sensitivity to experimental conditions for the soluble lignin measurement.

Methoxyl Determinations

The methoxyl contents of the wood preparations and of the isolated lignins from the extracted wood and the chlorited woods are given in Table II. The lignins from chlorited woods have a reduced methoxyl content, and in this respect are similar to chlorite lignin A reported by Barton (*14*) with a methoxyl content of 10.5%. Since Barton's product was a soluble lignin, it may be fair to use the similar values found for lignin remaining insoluble after chlorite treatment in the calculations.

The methoxyl data conform to the picture of lignin distribution which is deduced from the ultraviolet data. On the basis of methoxyl content, the preparations must contain far more lignin than would be indicated by the Klason method. If only acid-insoluble lignin were considered, the nonlignin methoxyl would increase from 0.8% in the extracted wood to the improbable values of 1.4 to 1.7% in the chlorited woods.

The marked decreases of the nonlignin methoxyl in the chlorine holocellulose preparations are understandable in view of the extensive polysaccharide losses which are shown to occur.

Loss of Polysaccharide Material

The corrected yields (E and G, Table I) indicate slight losses of carbohydrate material during chloriting and during the preparation of chlorine-monoethanolamine holocellulose from the wood. Some loss of carbohydrates during delignification is expected since Bublitz (*18*) and Jayme and Hanke (*19*) have isolated carbohydrate material from chlorite liquors. Thomas (*20*) ob-

Table II. Methoxyl in Lignin and Wood

Percentage of extracted wood

	Total lignin	*Methoxyl in lignin*[a]	*Methoxyl in lignin, wood basis*	*Methoxyl in wood preparation*	*Methoxyl not in lignin*[b]
Extracted wood	28.57	16.20	4.62	5.28	0.66
Chlorited wood					
A	23.98	11.26	2.70	3.23	0.53
B	15.60	10.67	1.66	2.40	0.74
C	9.50	10.39	0.99	1.62	0.63
Holocellulose[c] from:					
Extracted wood	4.37	...	0.44[d]	0.70	0.26
Chlorited wood					
A	3.86	...	0.39[d]	0.66	0.27
B	2.29	...	0.23[d]	0.53	0.30
C	1.86	...	0.19[d]	0.43	0.24

[a] Methoxyl in lignin is calculated on the basis of lignin.
[b] By difference.
[c] By chlorine-monoethanolamine method.
[d] Assuming 10% methoxyl in the lignin.

served polyuronide material in the wash waters in applying a chlorination method.

Although no great loss of polysaccharide material during chloriting is indicated until the Klason lignin falls below 6.4%, the loss upon further reducing the lignin to 2.3% is very serious. The polysaccharide loss as lignification approaches completion was noted by Wise (*3*), as well as in the earlier work of Jayme (*21*), although the effect of soluble lignin in obscuring the extent of polysaccharide loss was not clear at that time.

It seems that even a brief chlorite treatment results in a large loss on subsequent chlorine-monoethanolamine treatment. The more complete the delignification by chlorite, the greater the loss on chlorination. The stepwise loss of polysaccharides is shown clearly in Fig. 1. The delignification of wood by a combination of treatments does not appear a promising one if most of the polysaccharides are to be retained in the product.

The accuracy of the loss figures cannot be determined from yields alone, because of possible error in the soluble lignin values. In order to confirm the indications provided by yield and methoxyl data, a direct estimation of carbohydrate material in the products was undertaken by determination of total reducing sugars after hydrolysis. The hydrolysis was carried out for 3 hr. at 18 to 22°C. with 72% sulphuric acid, followed by dilution to 3% acid and heating at boiling temperature. Preliminary tests on the wood indicated that 5 hr. heating gave a maximum reducing value, and this time was used thereafter. The hydrolyzates were neutralized with barium carbonate, clarified with neutral lead acetate, and deleaded with dibasic potassium phosphate. The reduction followed the Munson and Walker procedure, and the cuprous oxide weights were converted to anhydroglucose. No great error is introduced by the presence of different sugars—e.g., the weights corresponding to 150 mg. of cuprous oxide are 65.9 mg. glucose (AOAC methods), 66.5 mg. xylose, and 68.2 mg. mannose (*22*).

The summations of reducing sugars, total lignin, and extraneous materials have been carried out, and the differences from the corresponding yield figures are given in Table III. The sum in each case (if loss of sugars during hydrolysis is taken into account) is in general agreement with the total yield. This indicates that the values obtained for soluble lignin, which was present in relatively large amounts, must be within the correct range and that they are likely to be too small rather than too large. The summations do not include acyl groups which were not determined.

Approximations in the reducing sugar determination may arise from the loss of sugar during the hydrolysis, neutralization, and clarification procedures, and from the possible presence in the hydrolyzate of nonsugar reducing materials. Pure D-glucose carried through the hydrolysis procedure used for the wood samples gave satisfactory recovery, as shown in Table IV. When a sugar mixture approximating the composition of a hydrolyzed softwood holocellulose was analyzed, the loss was not serious with boiling 3% sulphuric acid, but the additional treatment with 72% acid caused severe loss. Evidently, a figure of approximately 5% is a fair value and, consequently, the observed values were corrected for a 5% loss. Greater loss occurs when the sugars themselves are exposed to 72% acid, but this does not occur in the wood hydrolysis.

Table III. Analysis of Wood Preparations

Percentage of Extracted Wood

	Total reducing sugars[a]	*Total lignin*	*Ash*	*Alcohol soluble*	*Chlorine*	*Nitrogen*[b]	*Sum*	*Yield,*[c] *less sum*
Extracted wood	66.95	28.57	0.32	0.78	None	0.09	96.62	3.38
Chlorited wood								
A	64.73	23.98	0.89	0.74	0.58	..	90.92	3.28
B	65.71	15.60	0.74	0.62	0.45	..	83.12	2.00
C	61.53	9.50	0.72	0.45	0.34	..	72.54	3.76
Holocellulose[d] from:								
Extracted wood	65.15	4.37	0.06	..	1.10	2.18	72.86	1.30
Chlorited wood								
A	59.75	3.86	0.03	..	0.77	1.66	66.07	1.75
B	58.67	2.29	0.03	..	0.43	1.35	62.77	1.51
C	54.27	1.86	0.05	..	0.24	0.96	57.38	−0.12

[a] As glucose anhydride, the determined values divided by 0.95.
[b] As monoethanolamine (as N in extracted wood and not included in total).
[c] From Table I.
[d] By chlorine-monoethanolamine method.

Table IV. Recovery of Sugars by Reduction Procedure

Material	*Treatment*	*Found %, as* D-*glucose*	*Taken calculated %, as* D-*glucose*
D-glucose	Hydrolysis	96.9	100.0
Sugar mixture[a]	None, water solution	98.2	99.2[b]
Sugar mixture[a]	Clarification	98.3	99.2
Sugar mixture[a]	3% H_2SO_4, clarification	94.8	99.2
Sugar mixture[a]	72%, 3% H_2SO_4, clarification	86.8, 89.6	99.2
Glucuronolactone	Clarification	98.3	98.0[c]

[a] Glucose, xylose, manose, and glucuronolactone in a 40:10:10:4 weight ratio.
[b] Calculated from the respective cuprous oxide equivalents.
[c] From reference (*22*).

Glucuronolactone is not removed by clarification; when the lactone alone was carried through the clarification, it was recovered completely. Glucuronic acid (the sodium salt in water) does not give a precipitate with either barium or lead ions.

Alpha-Cellulose and Pentosans

The alpha-cellulose contents of the delignified products were measured by TAPPI Standard T 203 m-44. They were used as a measure of "resistant cellulose." It is shown (Fig. 1 and Table V) that extensive chloriting (chlorited wood C versus B) reduces the amount of alpha-cellulose. The alpha-cellulose content, as well as total carbohydrate present, is markedly lowered if a combined chlorite-chlorine treatment is used (holocelluloses from chlorited woods A, B, and C compared with holocellulose from wood). Fairly complete delignification by the methods used cannot be accomplished without a considerable reduction in "resistant cellulose."

Klason lignin was determined on all the alpha-celluloses. For chlorited wood A, the lignin content was so high that the value for alpha-cellulose, even after correction, is probably not meaningful. The other alpha-celluloses contained little or no acid-insoluble lignin. The presence of any acid-soluble lignin in the alpha-celluloses is not usually ascertained, and examinations of the lignin filtrates from the alpha-celluloses of chlorited products in this work indicate that the amount may be considerable. The calculated soluble lignin percentages (based on alpha-cellulose) were: chlorited woods A 4.8, B 3.2, and C 2.2%. A part of the measured ultraviolet absorbance may have had its origin in the sugars, but the calculated values given suggest that much of the apparent lignin in at least two of the alpha-celluloses must come from other sources.

The pentosans were determined by the bromide-bromate titration method according to TAPPI Standard T 223 m, including the 1% correction figure. The loss of pentosans (Table V) during delignification is considerable, particularly in the chlorinated products previously chlorited. However, the loss of pentosans by no means accounts for all the reducing sugar loss (column 1 of Table III), and it amounted to 15 to 48%, with an average of 28% of the total sugar loss for the various products.

The amounts of extraneous materials in cellulose preparations may be small compared to the uncertainties involved in determination of the more abundant constituents such as carbohydrates and lignin, but they are by no means negligible, and the amounts become more important as increasingly precise summations are sought. The extraneous materials determined on the products isolated in this work were ash, alcohol soluble in chlorited products (alcohol extraction is applied in the chlorine holocellulose isolation), chlorine, and nitrogen where monoethanolamine was used (Table III). Chlorine was determined by Volhard titration after an oxygen bomb decomposition, nitrogen by the Hengar modification of the Kjeldahl procedure. Considerable chlorine was found in all the products, and an appreciable retention of monoethanolamine was found, in confirmation of previous work (cf. *1*, Chapter 29).

Loss of Polyuronides

The products were analyzed for polyuronides by the CO_2 evolution method (*23*). The apparent content of uronic anhydride rises rapidly at the beginning of chloriting. This behavior has been observed consistently in these laboratories over a period of many years and apparently occurs as well when the delignification is accomplished by chlorination methods. The origin of the additional carbon dioxide has not been definitely established. Conceivably, additional polyuronide material could be formed by oxidation during delignification, but other sources of carbon dioxide exist. Wise, *et al.* (*3*), suggested that iron from the chlorite might be responsible, but they gave no experimental data.

It was thought possible that oxidation of carbohydrate material might lead to considerable quantities of nonpolyuronide carboxyl groups. These are known to be partly decarboxylated by acids (*1*, Chapter 31). Analysis of the products for total carboxyl was carried out by the calcium acetate method as described by Davidson (*24*), after removal of cations with 0.1 *N* hydrochloric acid. The following percentages of carboxyl as uronic anhydride (extracted wood basis) were found: Extracted wood 1.49, chlorited woods A 7.39, B 6.92, and C 5.94. Evidently, unusual quantities of carboxyl groups had not been formed, as these values are not much if any in excess of those found by the decarboxylation reaction.

Barton has reported (*14*) isolation of chlorite lignin products which contain carboxyl groups. Chlorite lignins A and B prepared by Barton were treated by the decarboxylation reaction. The yields of carbon dioxide are shown in Fig. 3. It is apparent that lignin products remaining in chlorited preparations may account for considerable carbon dioxide in the poly-

Table V. Analysis of Wood Preparations
Percentage of extracted wood

	Yield	*Alpha-cellulose*	*Alpha-cellulose*[a]	*Pentosans*	*Uronic anhydride*
Extracted wood	(100.00)	[b]	[b]	9.28	4.07
Chlorited wood					
A	94.20	68.39	60.72	8.95	6.97
B	85.12	50.90	49.68	8.75	6.28
C	76.30	44.54	44.54	8.29	5.22
Holocellulose[c] from:					
Extracted wood	74.16	47.49	47.40	8.41	4.60
Chlorited wood					
A	67.82	42.79	42.79	7.29	4.29
B	64.28	41.92	41.92	7.78	3.75
C	57.26	39.98	39.98	5.66	2.77

[a] Corrected for insoluble lignin.
[b] Not determined.
[c] By chlorine-monoethanolamine method

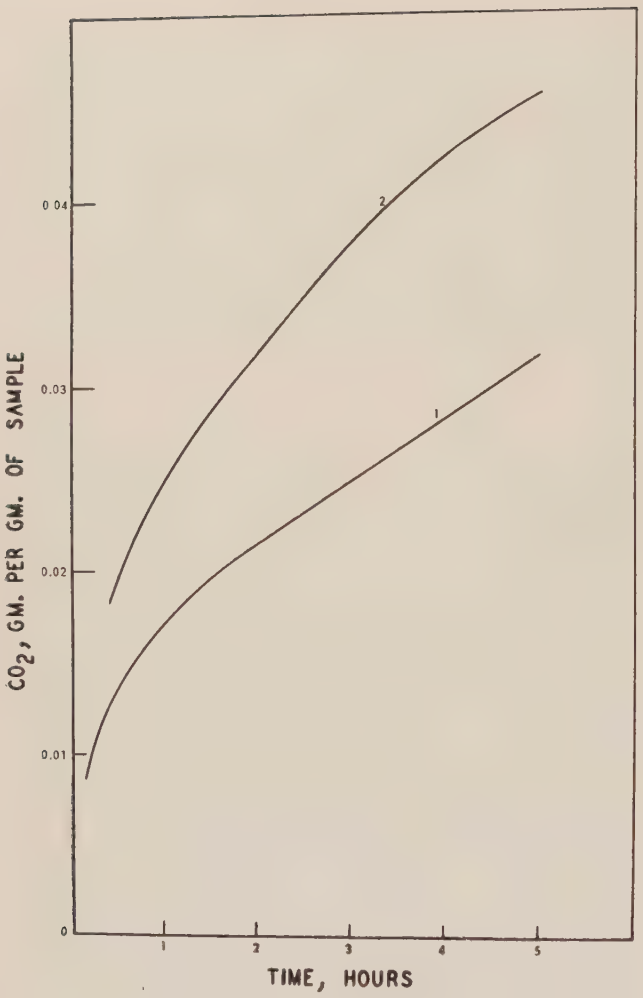

Fig. 3. Yield of carbon dioxide from chlorite lignins
(1) Chlorite lignin A. (2) Chlorite lignin B.

uronide test, and that the yield of carbon dioxide does not fall off quickly to a constant value. The apparent polyuronide content determined at 3 hr. decarboxylation time is 10 and 15% for chlorite lignins A and B, respectively. If the determined soluble lignin yielded carbon dioxide to the same extent, considerable, though not all of the apparent increase in polyuronides would be accounted for.

In view of the results, as well as the known loss of polyuronides as shown by Thomas (*20*) and others during even careful delignification, it seems fair to question whether the loss of uronic acids originally present in the wood may not be very much larger than that indicated by analyses based on carbon dioxide evolution. It is possible that the indicated polyuronide analysis would be the same on the wood and on the holocellulose, despite a considerable loss during the isolation.

THE APPLICATION OF ANALYTICAL METHODS

It is the purpose of the analytical chemist to characterize a material in terms of identifiable kinds of elements or molecular groupings. The complexity of wood has so far prevented wholly satisfactory characterization, and extensive delignification usually complicates the conditions of analysis and the possible interpretation of determined composition.

The isolation of cellulose preparations from wood yields products of such character as to give useful information about the starting material, but precise analytical treatment is difficult. The yield of individual or total sugar after hydrolysis provides data of fundamental value, but the variable yield upon hydrolysis precludes precise characterization by present methods. Treatment of the preparations as polysaccharides gives no information regarding component sugars, and requires consideration of noncarbohydrate contaminants, e.g., lignin residues, ash, anonic components such as chlorine which do not appear in the ash, nitrogen compounds, and carbohydrate products (resulting from the delignification process) which are not potentially recoverable as the component sugar originally present in the wood.

The problem of lignin is complicated by lack of precise definition, by the difficulty of distinguishing between extractives and lignin in a wholly precise way, and by the difference in behavior of lignin attendant upon the preparation of delignified preparations and wood pulps, in such a way that components that appear certainly to be derived from lignin no longer behave as did the lignin in the original wood. This has led to the confusions involved in testing preparations containing "soluble lignin."

Although proximate and empirical methods have been of great value in the past and will continue to give much useful information, it is evident that they lack the precision of statement and of procedure that are needed. The development and application of more precise and more fundamental methods is a necessary goal in more exact understanding of wood composition.

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Effect of Light on Coated Groundwood Papers*

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This paper summarizes an investigation of the degree of protection against light provided groundwood papers by commercial clay coatings. The light was similar to skylight filtered by ordinary window glass, but was applied at much greater intensity. Temperature of the papers was closely controlled at 31 to 33°C. Extent of deterioration was measured by changes in alpha-cellulose and blue reflectance. A purified sulphite, a soda-sulphite, and a newsprint were used as reference standards. It was found that clay coatings provide only partial protection against deterioration by light.

THE effect of light on cellulosic materials has been investigated by several persons with different points of view and different approaches. Among those who have reported on the photolysis of cellulose are Launer (*1, 2*), Webber, *et al.* (*3, 4*), Heuser and his students at The Institute of Paper Chemistry (*5, 6, 7*), Egerton (*8, 9, 10*), Lanigan (*11*), and Race (*12*). Appleby (*13*) has published a review of the literature and extensive bibliography on the action of light on textile materials.

The Institute of Paper Chemistry has given special attention to the fading of groundwood by light (*14–19*). Workers there have studied the nature of the color changes in groundwood upon exposure to light, and to a lesser extent, the nature of the color changes occurring in peroxide bleaching of groundwood. They concluded that absorption of light by the lignin caused at least part of the color changes. They also found that: (1) the changes produced in groundwood upon irradiation are nonlinear, most of the change occurring in the early stages of irradiation; (2) the pH of the groundwood influences the brightness of the exposed paper; (3) the effect of oxygen on the rate of color change was not large, and (4) the effect of relative humidity was small. They showed also that temperature alone had little effect on the color of groundwood but that the temperature coefficient of the photochemical change is large (i.e., that the temperature of the sheet during irradiation has a pronounced effect on the amount of change produced by a given period of irradiation).

Launer (*1*) has described an apparatus which controls the temperature of the irradiated sheet within narrow limits. A comprehensive investigation of the effect of light on papers using this apparatus was reported by Launer and Wilson (*2*). The light used was similar to skylight filtered by ordinary window glass, but was applied at much greater intensity. Some data on newsprint were included in their report. It was found that the violet-blue reflectance (4050 and 4360 A mercury lines) was decreased about 25% when newsprint was irradiated for 10 hr. in air, but increased about 6% when irradiated in the absence of oxygen. The decrease in alpha-cellulose due to irradiation was found to be nonlinear with respect to both intensity and time of irradiation. Buffering the groundwood sheets to a pH of 7.2 before irradiation rendered them considerably more stable than at pH 5.0, as measured by changes in alpha-cellulose. The decrease in lignin content on irradiation at the higher pH was also much less. The extractives (resins, fats, and waxes) did not appear to affect the light stability appreciably; a sheet extracted with an alcohol-benzene solution and with ether before irradiation showed about the same stability as an unextracted sheet.

APPARATUS

The irradiation apparatus has been described in previous publications (*1, 2*). The light source consisted of a commercial Pyrex-enclosed solid carbon-arc lamp with a cupric chloride filter and heat exchanger to remove the infrared. The light from this source as filtered by window glass was that originally selected to correspond as closely as possible to skylight similarly filtered. Constancy of light dosage was checked using a light meter as described by Launer (*20*). Positive control of paper temperature during irradiation was emphasized.

A water-jacketed aluminum backing plate was provided, against which a paper was held during irradiation by drawing air continuously through the sheet. This air stream passed out of the enclosed irradiation chamber in which the backing plate was mounted, circulated in a closed system over a saturated solution of sodium bromide maintained at 30.0 ± 0.2°C., and then returned to the irradiation chamber. The bromide solution maintained the relative humidity at about 57%.

The water circulating through the aluminum backing was also drawn from the bath maintained at 30.0 ± 0.2°C. Previous work (*1*) showed that under these conditions, the temperature of the paper was held within 31 to 33°C.

It was necessary to make two minor modifications in the original apparatus. The cupric chloride filter cell was redesigned so that the solution was in contact only with polymethyl methacrylate, butyl rubber, and glass. All rubber tubing was replaced with plastic.

SAMPLES STUDIED AND METHODS OF ANALYSIS

The samples used in the study are listed in Table I.

Papers 1130 and 1160 were made in the semicommercial mill of the National Bureau of Standards; manufacturing details were given in reference (*21*). Paper 1160 is a purified sulphite included in the study to represent a good quality of wood pulp paper with respect to aging; paper 1130 is a soda-sulphite and represents medium quality. The others, excluding the newsprint, are samples of commercial machine-coated

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* The question of the degree of protection against light given papers containing groundwood by commercial clay coating formulations was raised by B. W. Scribner, late Chief of the Paper Section of the National Bureau of Standards, and B. L. Wehmhoff, Chairman of the Paper Committee of the American Chemical Society.

Table I. Comparative Stability of Coated Papers Containing Groundwood[a]

No.	Fiber analysis[b] Groundwood	Fiber analysis[b] Chemical wood	Ream wt. (25 × 40—500), lb.	Coating wt.[c], % of decoated paper	pH, cold extraction	Alpha-cellulosed, %	Decrease in alpha-cellulosed[d] due to Light: Irradiated as-received, %	Light: Irradiated after decorating %	Heat, %	Reflectance, Blue filter: As-received	Reflectance, Blue filter: After decoating	Changes in reflectance due to irradiation: Irradiated as-received	Changes in reflectance due to irradiation: Irradiated after decoating
3499	50	50	...	..	6.1	79.9	...	..	+0.3	...	...	.....	.....
3500	50	50	35.1	31	6.5	80.7	7.9	..	....	0.634	...	−0.052	.....
3502	50	50	35.1	48	7.4	87.2	5.5	17.7	0.1	0.672	0.643	−0.049	−0.140
3503	50	50	31.8	30	5.9	86.7	7.9	..	....	0.611	...	−0.055	.....
3504	40	60	37.2	33	6.1	85.1	7.5	..	....	0.654	...	−0.065	.....
3505	50	50	35.6	34	7.3	85.2	4.7	12.5	....	.678	0.654	−0.069	−0.101
3507	..	100	42.8	29	7.8	81.6	0.0	..	1.7	0.717	...	0.000	.....
3510	..	100	32.1	42	8.6	83.7	0.5	..	....	0.705	...	+0.020	.....
1160	..	100	58.0[e]	..	5.7	89.6	4.8[f]	..	0.4[e]	0.804	...	+0.025	.....
1130	..	100	55.5[e]	..	5.0	71.2	1.7[g]	..	3.3[e]	0.676	...	+0.038	....
Newsprint	75	25	37.9	..	4.4	85.5	22.0	..	....	0.522	...	−0.084	....

[a] The coated papers used in the study were supplied by the West Virginia Pulp & Paper Co., the Consolidated Water Power & Paper Co., the Mead Corp., the Crown Zellerbach Corp., the St. Regis Paper Co., and the Kimberly-Clark Corp.
[b] Fiber analysis by C. W. Hall.
[c] Both sides.
[d] Per cent of total cellulose.
[e] From reference (*21*).
[f] This value is somewhat in doubt. The alpha-cellulose decrease from reference (*2*) for similar condition of irradiation is 1.3, and the value in Table II (water filter instead of $CuCl_2$ filter) is 1.8.
[g] This value is much lower than the average decrease of 5.6 for soda-sulphite papers of the same fiber furnish as reported in reference (*2*).

papers; most of these contain groundwood, and all are coated on both sides.

The sheets were irradiated for 16 hr., 8 hr. on each side. Several specimens were decoated before irradiation; these specimens yielded very significant data.

The volumetric alpha-cellulose method (TAPPI Standard T 429 m-48) served as the principal criterion of degradation. A Koerner grinder (*22*) was used to prepare samples for the alpha-cellulose test. Changes in reflectance were measured with the Hunter Multipurpose Reflectometer (*23*). Fiber analyses were made according to TAPPI Standard T 401 m-42. Basis weight and pH were determined by TAPPI Standards T 410 m-45 and T 435 m-52, respectively. The coating weight was determined by TAPPI Standard T 407 m-49 using Rhozyme D-200, but no alkali was added to the enzyme solution. Alpha-cellulose was determined on some of the papers after heating at 105°C. for 72 hr. (TAPPI Standard T 453 m-48).

EXPERIMENTAL RESULTS AND DISCUSSION

Table I contains the data on the effect of light and heat on the papers. The data show that the coating does not protect papers containing groundwood from extensive deterioration by light. However, the coating does provide partial protection as shown by the approximately threefold decrease in alpha-cellulose for papers 3502 and 3505 when irradiated after removal of the coating.

Changes in reflectance are given for the blue filter only of the Hunter instrument. Changes in reflectance with the amber and the green filters were not particularly significant. In agreement with earlier findings (*2*) uncoated papers which do not contain appreciable amounts of lignin are bleached under these conditions of irradiation. The coated papers containing no groundwood, 3507 and 3510, show no significant change in alpha-cellulose upon exposure to light. Obviously the coating protects them sufficiently to render any change too small to measure, since the changes for delignified fibers are comparatively small to begin with. The papers containing groundwood, with or without coating, show significant losses in alpha-cellulose and definite yellowing. The heat stability of all the papers is good.

Table II contains data on the effect of light and heat on several widely differing types of papers, ranging from newsprint to 100% rag. Number 1191 is an old-rag paper made in the semi-commercial mill of the National Bureau of Standards; manufacturing details are given in reference (*21*). Number 1160 has already been discussed in connection with Table I. Papers 2060B, 2060A, and the newsprint are commercial papers and contain varying amounts of bleached or unbleached groundwood. The papers in Table II were irradiated with a different arc lamp of the same type as used on the papers in Table I. A water filter was used instead of a solution of cupric chloride.

The accelerated aging test was carried out at 100°C. instead of 105° as now specified, and no reflectance measurements were made. The papers containing groundwood have a much lower stability toward light than those which are groundwood-free, but the heat stabilities of all are of the same order of magnitude. Bleached groundwood (2060B) does not appear to be appreciably more stable with respect to alpha-cellulose change than unbleached groundwood, although a con-

Table II. Effect of Lignin on the Light Stability and Heat Stability of Papers

No.	Fiber analysis	pH, cold extraction	Alpha cellulose, %[a]	Decrease in alpha-cellulose[a] due to: Light, %	Decrease in alpha-cellulose[a] due to: Heat, %	Color changes due to light
1160	Purified sulphite	6.9	89.3	1.8	0.4	Slight bleaching
1191	Old rag	6.8	91.0	3.3	3.1	Slight bleaching
2060B	50% bleached groundwood 50% bleached sulphite	...	80.4	19.4	3.5	Objectionable yellowing
2060A	70% unbleached groundwood 30% unbleached sulphite	...	84.5	32.4	2.5	Greater yellowing
Newsprint	75% groundwood 25% sulphite	...	89.8	40.2	1.2	Still greater yellowing

[a] Per cent of total cellulose.

trol of 50% unbleached groundwood and the same bleached sulphite would be required to clarify this point. The results would probably vary with the type and extent of bleaching.

SUMMARY

1. A clay coating provides only partial protection against deterioration by light for papers containing groundwood.

2. The heat stability of papers containing groundwood is very good.

3. The blue reflectance of papers containing groundwood decreases considerably due to irradiation. In keeping with previous findings, the blue reflectance of groundwood-free papers usually increases upon irradiation.

4. Papers which were decoated before irradiation showed much greater changes in reflectance and in alpha-cellulose than specimens of the same papers which were irradiated before decoating.

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The Chemical Nature of the Extractives from Red Alder

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The total extractive content of red alder bark was 24.0% while that of the wood was 8.6%. The chief white coloring matters in the bark are the triterpene alcohol, alnulin and its corresponding triterpene ketone, protalnulin. An unreactive material with a melting point of 254°C., phytosterol, and linoleic acid were also isolated by extraction with hexane. The red coloring matters in red alder are a phenolic xyloside, phlobatannin, a tannin-carbohydrate complex, and phlobaphene. Infrared absorption spectra of the phenolic xyloside, phlobatannin, and phlobaphene were similar. The phenolic xyloside has properties similar to those of the phlobatannin and amounted to 26.9% of the alcohol extract from the bark. Its ability to form dark-red colors, even more so than the phlobatannin, indicated that it might be the chief cause of the red stain in the wood. It exhibited the same color changes with variation of pH that the stain in the wood does. Tannin analyses showed that the bark contained 4.2% tannin and the wood 0.74% tannin calculated on the oven-dry weight of the materials. Part of this tannin was soluble in alcohol and amounted to 28.7% of the alcohol extract from the bark. Additional tannin was soluble in water and appeared to be combined with carbohydrate matter. Sugars found in the extracts were glucose, xylose, and arabinose.

Red alder, *Alnus rubra*, Bong., often called Oregon alder, is the major hardwood species in the Pacific Northwest with an estimated stand in Oregon and Washington of 2.5 billion board feet, log scale (*1*). Its wood has been used for many years in the manufacture of furniture, but a relatively new use is in the manufacture of pulp. As other hardwoods have become more difficult to obtain, a large amount of interest has been shown in the utilization of red alder.

The red staining material in red alder has long been a source of trouble in the production of lumber. Special care is required in drying the wood to prevent undesirable or uneven colors. If the wood is kiln dried, the initial temperature will often influence the color of the finished product. The red staining material has also been reported as a source of trouble in bleaching pulp made from this species, although a basic peroxide bleach works fairly well.

The purpose of this investigation was to determine the properties and chemical nature of the coloring matters in red alder. Preliminary work showed that the bark contained the coloring matters in a much higher concentration than the wood. The outer surface of the bark of red alder is usually greyish white or chalky white, whereas the inner bark may vary from orange to reddish brown. The wood is light colored when freshly cut, but quickly ages to flesh color or light brown with a reddish tinge. Often the staining appears as orange or red streaks.

A search of the literature revealed that little previous work has been done on red alder bark, but that the extractives from the barks of grey alder, *Alnus incana* L., black alder, *A. glutinosa* L., and green alder, *A. viridis*, have been investigated (*2*, *3*, *4*). These contain 3.6 to 5.5% ether-soluble matter consisting of protalnulin, m.p. 236°C.; alnulin, m.p. 260°C.; al-

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niresinol, m.p. 192–193°C.; an unidentified compound, m.p. 254°C.; and other unidentified materials. Alnulin has been reported (*5*) to be identical with taraxerol, an unsaturated, pentacyclic, triterpene, secondary alcohol; whereas, protalnulin is considered to be identical with taraxerone, the corresponding triterpene ketone.

An analysis of red alder wood for the percentage of extractives, holocellulose, lignin, pentosan, etc., has been made (*6*). The tannin content of the wood was found to be 0.7% whereas that of the bark was found to be 3.3% (*7*). A seasonal variation in the tannin content of British Columbia red alder from a minimum in January to a maximum in March has been reported (*8*).

EXPERIMENTAL

The samples used in this investigation were obtained in July, 1951, from trees of sawlog size, 15 to 20 in. in diameter. Cross-sectional disks were cut from the butts of the trees felled for this purpose. A bright red-orange stain from the bark streaked the wood when the logs were sawn. The bark and the wood were separated immediately and each was ground to pass as 20-mesh screen. Part of the freshly ground material was stored in a refrigerator and the remainder was spread out to air dry in the sun.

Extractive Content of the Bark and the Wood

The relative amounts of the total extractive content of the fresh moist bark and of the wood were determined. Extractions with organic solvents were made in glass Soxhlets and with hot water in extractors used for tannin analysis (*9*). The moisture contents were 33 and 38% for the bark and for the wood, respectively. The results are given in Table I.

Table I. Extractive Content of Red Alder Bark and Wood
Percentage of oven-dry weight of materials

Solvent	*Wood, %*	*Bark, %*
Hexane	..	3.28
Benzene	..	0.75
Ethyl ether	1.15	0.22
95% ethyl alcohol	3.81	11.21
Hot water	3.64	8.55
Sum of extractives	8.60	24.01

Comparable tannin analyses of the wood and of the bark were made by the method of the American Leather Chemists' Association (*9*). These results are shown in Table II. The maximum yields of tannin and of total solids were obtained with a 9-hr. extraction period.

Table II. Tannin Analyses of Wood and Bark
Percentage of oven-dry weight of materials

Material	*Bark, %*	*Whole wood, %*	*Heartwood, %*
Total solids	15.92	3.43	3.92
Soluble solids	14.10	2.94	3.54
Non-tannin	9.90	2.20	2.60
Tannin	4.20	0.74	0.94

A green, tacky material was obtained both from the hexane and from the benzene extractions. The ether extract was light brown in color. A red, sticky material which was difficult to dry was removed by alcohol. The water extract was a reddish, cloudy solution that formed a red powder when dried.

Constituents of the Extractives from Red Alder Bark

Hexane Solubles. Forty-five hundred grams of air-dried bark were extracted in batches with hexane in a large glass Soxhlet-type extractor until there was no noticeable color in the extracting solvent. The hexane was removed under reduced pressure to give a green, sticky residue, which amounted to 3% of the oven-dry weight of the unextracted bark. A 2.5-gram sample of this extract was dissolved in ether and washed with a 5% potassium carbonate solution. The free acids removed by the carbonate amounted to only 7.44% of the hexane extract.

Saponifiables. Three grams of the hexane extract were saponified by refluxing for 4 hr. with 3 grams of potassium hydroxide in 100 ml. of alcohol and about 10 ml. of benzene. The solvent was removed on a hot water bath and replaced with water. This aqueous emulsion was transferred to a separatory funnel and shaken with diethyl ether to remove the alcohols and other neutral compounds. The potassium salts of the acidic materials remained in the water layer, which was acidified and the organic acids then extracted with ether. Removal of the ether on a hot water bath and in a vacuum oven at 40°C. yielded a green, viscous oil. Conversion to the methyl esters with methanol and sulphuric acid according to the method of Wolff and Scholze (*10*) indicated that the major part consisted of fatty acids. Re-saponification of the methyl esters gave a light-yellow, greasy oil, which had a neutral equivalent of 290 and a Hanus iodine number of 80.3.

An additional quantity of the fatty-acid fraction was prepared for further investigation. Working with moderately large laboratory samples was difficult for the extract had a pronounced tendency to froth on saponification. In addition, the aqueous, saponified mixture formed a stable emulsion, which made recovery of the neutral and acid fractions tedious. The freshly prepared acid fraction had a pronounced fatty-acid odor. A dark brown-colored fraction was insoluble in hexane and was removed with filtration.

The hexane-soluble fraction became a thick grease on standing. Oxidation with cold, dilute potassium permanganate gave white crystals of tetrahydroxy stearic acid, m.p. 170–172°C., which indicated that linoleic acid was present. Attempts at separation of the crude acid mixture with solvents were not satisfactory. A partial separation was obtained by extractions and recrystallizations from acetone and hexane. At least four distinct products appeared to be present in the acid fraction: A light-brown acid, m.p. 250–252°C.; a white crystalline acid melting between 94 to 95°C.; a white crystalline acid melting at 54°C.; and linoleic acid.

Unsaponifiables. The neutral materials and the saponified alcohols were soluble in ethyl ether after the saponification. Distillation of the ether left an orange, crystalline residue. When this material was dissolved in hot ethyl acetate and allowed to cool, a a small amount of material crystallized out as fine white needles. Following recrystallization, twice from

ethyl acetate, once from ethanol, and once from acetone, it melted at 260–261°C., with sublimation to fine, feathery crystals.

No optical rotation could be detected for this compound in a chloroform solution. The material absorbed bromine from a carbon tetrachloride solution, indicating unsaturation. It was soluble in methanol and was crystallized easily from ethyl acetate, acetone, or ethanol. An acetate derivative prepared with acetic anhydride and pyridine melted at 292°C. These are the properties reported for alnulin (*3*).

Some of the alnulin was also isolated by crystallization from an acetone solution of the total hexane extract. This indicated that a part was present as the free alcohol. Later, this material was obtained also by extraction with hot hexane of a white crystalline solid which had separated from the ethyl ether extract from eight kilograms of air-dried red alder bark.

The ethyl acetate solution of the remaining unsaponifiables was concentrated and placed in a refrigerator. A large amount of a second white, crystalline material separated from the orange solution. After recrystallization from ethyl acetate, twice from ethanol and twice from acetone, the crystals melted at 236°C. The optical rotation in chloroform was $(\alpha)_D^{20°} = +2.5°$. A 2, 4-dinitrophenyl hydrazone was prepared and crystallized from ethanol as fine, yellow needles. These were recrystallized from acetone to give clear, cubic crystals with a melting point of 127–128°C.

A substance named protalnulin, which is present in the barks of gray, black, and green alders, has similar properties, but no derivatives have been reported (*3*). Protalnulin has been reported to be identical with taraxerone, the triterpene ketone corresponding to the alcohol, taraxerol (*5*).

More protalnulin was separated also from later fractions because of its lower solubility in hexane than alnulin. The material comprised the major part of a white, crystalline solid which separated from an ethyl ether extract from red alder bark. Protalnulin appeared to be the chief white coloring matter which occurs in red alder bark.

The next material which separated from the ethyl acetate solution, after more concentration and standing, was also a white, crystalline substance. It was fairly soluble in acetone or ethanol, but only slightly soluble in hexane. After several recrystallizations from hexane, ethanol, and acetone, it melted at 254°C. Attempts were made to prepare the common alcohol or ketone derivatives, but none were obtained. A material has been reported to be present in the barks of black alder and green alder with a melting point of 254°C., but since no derivatives have been mentioned (*3*), the establishment of its identity with the material present in red alder barks was not possible.

The orange solution which remained after the incomplete separation of the above three compounds was then evaporated to dryness and the thick, yellow, residue was extracted with hot hexane. The hexane solution was cooled, and the fine, white crystals which separated were recrystallized from acetone, hexane, and ethanol. The resulting white crystals melted at 134 to 135°C. They gave a positive Liebermann-Burchard test for sterols. A mixed melting-point determination was made with the phytosterol isolated from white fir bark and no depression in the melting point was observed. The acetate derivative, made by heating with acetic anhydride and pyridine, had a melting point of 117 to 118°C. The residue from the separation of the phytosterol still contained appreciable amounts of white, crystalline materials. Additional separations with several solvents were attempted and a number of white, crystalline products were obtained, but repeated recrystallizations did not appear to produce pure compounds. Previous reports on black and green alder barks (*2*, *3*) mentioned the isolation of substances with melting points of 192 to 193°C. and 194 to 195°C. Similar fractions were obtained from red alder bark but these did not appear to be pure compounds. No quantitative fractionation of the unsaponifiable material was possible by solvents; the separations were laborious and not exact.

Ether Solubles. The hexane-extracted bark residue was re-extracted with ethyl ether and gave a soft-green extract which amounted to 0.8% of the oven-dry weight of the bark. This was saponified with alcoholic potassium hydroxide and separated into saponifiable and unsaponifiable fractions.

The unsaponifiable fraction was an orange, crystalline material which amounted to 23.3% of the ether extract. It was dissolved in hot ethanol and the solution allowed to cool. Fine, white needles separated, and melted at 133 to 134°C. after they were recrystallized from ethanol and acetone. This substance was identical with the phytosterol present in the hexane extract.

As the remaining alcohol solution was concentrated and cooled in a refrigerator, a large amount of white, crystalline material separated. This was shown to be protalnulin. The alcoholic filtrate was evaporated to dryness and dissolved in hot hexane. When the solution was cooled, more protalnulin separated.

The hexane solution was then concentrated and the precipitate which formed was removed by filtration. More of the phytosterol was present in the hexane-soluble material, and was crystallized by cooling the solution in the refrigerator. The material which had been filtered from the hexane solution was dissolved in acetone and fractionally crystallized to give alnulin. Further concentration of the acetone solution resulted in the isolation of a crystalline material which melted at 254°C. The material remaining in solution was an orange-colored resin with small amounts of each of the four compounds previously isolated. Therefore, the ethyl ether solubles were similar to the hexane solubles.

Alcohol Extract. Four hundred and sixty grams of bark, which had been previously extracted with hexane and ether, were placed in a large Soxhlet-type extractor. The bark was then extracted with 95% ethanol for about 50 hr., to give 1900 ml. of a dark red-brown solution. Evaporating the alcohol from a 100-ml. aliquot, and drying the residue in an oven at 105°C. showed that the solution contained 2.2 grams of solids per 100 ml. Thus, an extract yield of 9% of the oven-dry weight of the bark was obtained.

Phlobaphene. Five hundred milliliters of water were added to 400 ml. of the alcohol extract. Removal of the alcohol in a current of air caused the phlobaphene to precipitate. The aqueous suspension was centrifuged to remove the last traces of phlobaphene.

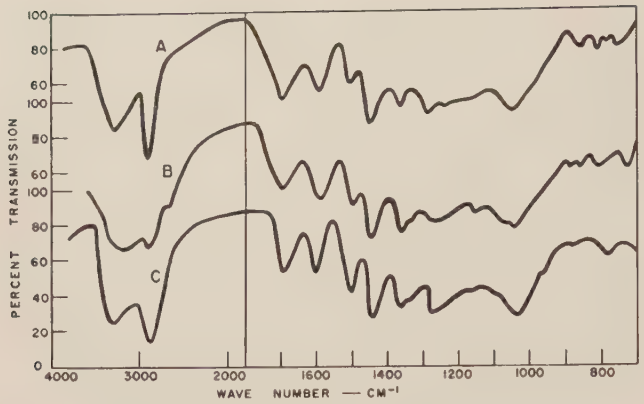

Fig. 1. Infrared spectrum of phlobaphene (A), tannin (B), and phenolic xyloside (C)

After the water-soluble material had been decanted, the phlobaphene was washed with water and again centrifuged. Repeating this procedure gave a substance free from water-soluble materials. To remove traces of ether soluble material, the moist phlobaphene was dissolved in 20 ml. of acetone and poured into 400 ml. of absolute ether. The precipitated phlobaphene was filtered on a Buchner funnel and dried in a vacuum desiccator. A light-tan powder, which amounted to 11.7% of the alcohol extract, was the final product.

Methanol, ethanol, or dioxane readily dissolved the phlobaphene to give dark red-brown solutions. Ferric chloride imparted a green color to a dilute alcoholic solution of this substance, indicating the presence of a catechol nucleus. The methoxyl content was 4.14%, which was not decreased by further purification by extraction with benzene, or hexane.

The infrared absorption spectrum, shown in Fig. 1, was determined on the dry phlobaphene mulled in Nujol. The presence of a benzene nucleus was indicated. The absorption peak of 1700 cm.$^{-1}$ is characteristic of a carbonyl group. The hydroxyl band had a greater intensity than is usual for this type of material.

Water-soluble components. The material which remained in the water solution, after the removal of phlobaphene amounted to 88.3% of the alcohol extract. This cloudy, red solution gave a green color with ferric chloride, and reduced Fehling solution. Changing the pH of the solution produced variations in the color from dark red at pH 10 to yellow red at pH 3. When the acidic solution was heated, a red precipitate formed.

Paper-partition chromatography was used to obtain an indication of the number of substances present in the water solution of the alcohol extract. A solvent system of 40% butanol, 10% ethanol, and 50% water was found to be satisfactory. One and one-half inch strips of Whatman no. 1 filter paper were used as the adsorption medium. A solution of silver nitrate in ammonium hydroxide was used to develop the chromatograms.

Four separate spots appeared when the water-soluble components of the alcoholic extract were chromatographed, indicating the presence of four compounds. The first spot did not move from the starting point. The next two spots had R_f values of between 0.2 and 0.3; that of the last spot was approximately 0.7.

Tannin. Most tannins found in nature can be extracted with alcohol and are soluble in water. Therefore, the first material sought in the water solution from the alcohol extract was tannin. A tannin determination with hide powder (*9*) showed that 28.7% of the total alcohol extract was tannin. The detanned solution gave no spot at the starting point of the paper chromatogram. This indicated that this spot was caused by tannin.

Tannins are usually isolated from water solutions by either an ethyl acetate extraction or by a sodium chloride precipitation. The aqueous solution extracted for 11 hr. with ethyl acetate in a liquid-liquid extractor showed that 33.5% of the total alcohol extract was soluble in this solvent. A chromatographic analysis showed that the ethyl acetate extract contained all of the four components. The spot with an R_f of approximately 0.7 had the highest intensity. The two spots with lower R_f values were much less intense. Therefore, it was evident that the extract was a mixture and not pure tannin.

The aqueous solution which remained after the ethyl acetate extraction was saturated with sodium chloride. The red material that precipitated was removed by centrifuging, and washed thoroughly with a saturated sodium chloride solution. It was then treated with methanol and the insoluble sodium chloride filtered off. The methanol solution was placed in a tared dish, the solvent removed by a current of air, and the residue dried to constant weight in a vacuum oven at 30°C. The yield was 8.95% of the alcohol extract. Chromatographic analysis showed that it was almost entirely tannin, but contained a slight trace of sugar.

The tannin was further purified by placing it in a Soxhlet extractor and extracting with ethyl acetate, benzene, ether, and hexane. The final product was a fine, reddish powder that was readily soluble in hot water, giving a reddish solution that turned dark red when a base was added. When the solution was acidified, it became yellow, and in a few hours gave an insoluble red precipitate. The insoluble material also separated on boiling a concentrated aqueous solution of the tannin for a short period of time. The purified tannin fraction was soluble in ethanol, methanol, and dioxane, but insoluble in dry ethyl acetate. The methoxyl content was 3.52%. An aqueous solution gave a green color with ferric chloride and a precipitate with bromine or gelatin.

The infrared absorption spectrum for the tannin mulled in Nujol is shown in Fig. 1. It indicated the presence of a benzene nucleus. The carbonyl band at 1700 cm.$^{-1}$ was less intense than the corresponding band for the phlobaphene. A strong band was present at the characteristic hydroxyl frequency.

Sugars. The nontannin materials left after the hide-powder analysis for tannin amounted to 59.6% of the total alcohol extract. Since two of the three spots obtained on the chromatogram of this solution appeared to be caused by sugars, a reducing-sugar determination was run on the water-soluble components of the alcohol extract after decolorization with neutral lead acetate.

A 300-ml. aqueous solution of the water solubles from the alcohol extract was treated with 50 ml. of a saturated, neutral, lead acetate solution. The insoluble lead salts were removed by centrifuging, washed twice with water in the centrifuge, and the washings added to the solution of the soluble materials. Excess lead was removed from the sugar solution with dipotassium phosphate. Chromatographic analysis revealed that only

Table III. A Comparison of the Xyloside and Tannin

Test or property	*Xyloside*	*Tannin*
Ferric chloride	Green color	Green color
Base	Dark-red color	Dark-red color
Heating with acid	Red insoluble material	Red insoluble material
Solubilities	Soluble in most alcohols, dioxane, and hot ethyl acetate	Soluble in most alcohols, dioxane. Not soluble in dry ethyl acetate
Chromatography	R_f about 0.7	R_f 0
Infrared spectra	Carbonyl at 1700 $cm.^{-1}$	Carbonyl at 1700 $cm.^{-1}$
Combined with sugar	Yes	Possibly
Methoxyl content	3.66%	3.52%

the two lower—R_f—value spots were now present. A reducing-sugar determination by the Schaffer-Somogyi method (*11*) showed that 32.7% of the alcohol extract was reducing sugar, calculated as glucose. No increase in reducing-sugar content was obtained by hydrolysis for 1 hr. with 2% hydrochloric acid. This indicated that all of the sugars present were monosaccharides.

The sugars could also be separated by removing the other materials by means of *n*-amyl alcohol extraction. A 100-ml. aqueous solution containing 1.53 grams of water-soluble components of the alcohol extract was shaken with five 600-ml. portions of *n*-amyl alcohol. A 25-ml. aliquot of the water layer was evaporated to dryness on a steam bath and dried to constant weight in an oven at 105°C. This showed that the material remaining in the water layer amounted to 33.3% of the total ethanol extract. Chromatographic analysis showed that the water layer contained only free sugars.

To determine the identity of the two sugars present, several of the more common natural-occurring sugars were chromatographed on the same strip of paper as the free sugars. The spots for glucose and xylose were exactly opposite the two spots produced by the two sugars. This showed that glucose and xylose were present in the alcohol extract from red alder bark.

Complex phenolic xyloside. Subtracting the 32.7% reducing-sugar content from the 59.6% nontannin material, left 26.9% of the alcohol extract not accounted for. The chromatogram spot with an R_f of approximately 0.7 also needed an explanation. A high intensity was noticed for this spot on the chromatograms for the material extracted by ethyl acetate from a water solution of the water-soluble components of the alcohol extract. However, tannin, glucose, and xylose were also present in this fraction. Since the pure tannin was not soluble in dry ethyl acetate, it was believed that a direct extraction of the bark with dry ethyl acetate would remove the unknown material in a relatively pure state. For this purpose, 500 grams of bark which had been previously extracted with hexane and ethyl ether, were extracted with dry ethyl acetate in a large Soxhlet-type extractor. The red-colored extract was concentrated to 150 ml. and poured slowly into 1 liter of hexane with vigorous agitation. The light, flocculent precipitate was allowed to settle, removed on a Buchner funnel and immediately placed in a vacuum desiccator to dry. The dried material was a light, cream-colored powder which amounted to 0.9% of the oven-dry weight of the bark. This material was extremely hygroscopic, and it darkened and became sticky if exposed to undried air for more than a few seconds. Several attempts were made to crystallize this material from alcohol, acetone, and many other solvents, but all resulted in the formation of a sticky material on the bottom of the container. When the paper-chromatography method of analysis was applied to this material, the presence of a large amount of free sugars along with the unknown material of high R_f was shown.

A solution of 300 mg. of the ethyl acetate extract in 20 ml. of water was placed in a separatory funnel and extracted with 200 ml. of *n*-amyl alcohol. The amyl alcohol was washed four times with fresh portions of water and the combined water solutions were evaporated to dryness on a steam bath and dried to constant weight in an oven at 105°C.

The material which was preferentially soluble in water amounted to 50.5% of the total ethyl acetate extract of the bark; chromatographic analysis showed the water extract to be composed of glucose and xylose. A similar analysis showed the unknown material to be present in the amyl alcohol layer. Fifty milliliters of water were added to the amyl alcohol extract, and the alcohol removed with a current of air. Enough sulphuric acid was added to this solution to make a 2% solution. It was refluxed for 1 hr., extracted with three 20-ml. portions of *n*-amyl alcohol, and the alcohol extracts were evaporated, dried, and weighed. This showed that only 67% of the hydrolyzed material was now preferentially soluble in amyl alcohol. By difference, 33% of the hydrolyzed material was present in the water layer. Chromatographic analysis showed that the water solution contained only xylose. Since this xylose was obtained by hydrolyzing the unknown material, the material was concluded to be a xyloside. Assuming one xylose unit per molecule, a molecular weight of about 400 for the xyloside, or about 265 for the aglycon, was calculated.

Some of the dry ethyl acetate extract from red alder bark was dissolved in warm water and treated with neutral lead acetate. The lead salts of the xyloside were removed by centrifuging, and washed twice with water and twice with methanol in the centrifuge. The material was then suspended in methanol and decomposed with hydrogen sulphide gas. After removing the lead sulphide, the methanol was evaporated, and the residue washed first with hexane, then with hot benzene, and finally dried in a vacuum desiccator. The product was a light red-orange powder which was not as hydroscopic as the xyloside-sugar mixture. Attempts were made to crystallize it from a variety of solvents without success. It had a methoxyl group content of 3.66%. If it is assumed that only one methoxyl group is present per molecule of xyloside, then a molecular weight of about 850 for the xyloside is obtained by calculation. Inasmuch as this value is about twice the value obtained by the relative amount of xylose present, the material appears to have two xylose units, two aglycon units, and one methoxyl group. Paper-partition chromatography showed the compound to have an R_f value close to 0.7, which would indicate that the material had a molecular weight lower than the tannin or phlobaphene since the latter two substances did not move from the starting point.

The phenolic xyloside dissolved in hot water to give a yellow solution. This solution gradually changed to a red color upon standing for several days at room tem-

Table IV. Composition of the Alcohol Extract

Component	Per cent
Phlobaphene	11.7
Tannin	28.7
Glucose and xylose	32.7
Phenolic xyloside (by difference)	26.9
	100.0

perature, or in a few hours when heated. Boiling an acidified solution gave an insoluble, red, phlobaphene-like material.

The color of the xyloside in an aqueous solution was dependent on the pH. It was yellow at pH below 4.5, but became red at a pH close to 4.8. As the basicity was gradually increased, the red color of the solution became more intense, until at pH above 8, it gave a very dark-red solution. The color developed by the phenolic xyloside in an alkaline solution was much darker than the colors developed by the tannin or the phlobaphene. It was also darker than the colors produced in basic solution by catechin or dihydroquercetin.

A red alder board with colorations of red and yellow was tested with nitrazine indicator paper and it was found that the pH of the wood with a red color was about 5.3 and that of the wood with a yellow color was about 4.8.

The xyloside was soluble in methanol, ethanol, *n*-amyl alcohol and dioxane. It was also dissolved by acetone if some water was present. It produced a green color with ferric chloride in aqueous solution, and a cream-colored precipitate when treated with lead acetate. An excess of hide powder absorbed some of the compound. Tests for anthocyanins with hydrochloric acid and amyl alcohol and the Wilson boric acid test for flavones (*12*) were negative. Inasmuch as no color was produced when the xyloside was treated with magnesium and concentrated hydrochloric acid, it was not a flavanone or flavone.

Methylation with dimethyl sulphite in alkaline solution gave a product soluble in ethyl ether but not crystallizable. Similarly, methylation with diazomethane and acetylation with acetic anhydride gave products that could not be crystallized.

The infrared absorption spectrum was determined on the xyloside in a Nujol mull and is shown in Fig. 1. A carbonyl band appeared at 1700 cm.$^{-1}$, the same place that it appeared in the tannin and phlobaphene. The presence of a benzene nucleus and hydroxyl groups were indicated.

A comparison of the properties of the phenolic xyloside with the properties of the alcohol-soluble tannin is given in Table III.

Table IV summarizes the percentage composition of the alcohol extract.

Hot-water Extract. One kilogram of air-dried bark which had been previously extracted with hexane, ethyl ether, and 95% ethanol was extracted further with five 2-liter portions of cold water and three 2-liter portions of hot water. The 16 liters of combined extract were concentrated to 500 ml. under 50°C. in a vertical, long-tube, natural-circulating-type vacuum evaporator. A 50-ml. aliquot was placed in a tared dish, evaporated to dryness and weighed, to give a yield of 2.2% water-soluble material.

Table V. Reducing Sugar after Hydrolysis of Crude Carbohydrate

Hydrolysis period, hr.	Reducing sugar, %
0	7.8
1	27.4
2	50.0
4	51.2
6	54.0
8	50.6

Carbohydrate material. The water extract was treated with an excess of hide powder to remove tannin. Following this it was concentrated to 100 ml. in a current of air and poured into 3 liters of alcohol. The precipitate was filtered on a Buchner funnel, washed with ethanol, and dried in a vacuum desiccator. A reddish-colored carbohydrate product, which amounted to 61.4% of the water extract, was obtained.

After drying, the crude material was only partially soluble in hot water. It was hydrolyzed for $^1/_2$ hr. with 2% hydrochloric acid. This converted about 19% of the crude carbohydrate to insoluble material and an additional 6% became insoluble when the solution was neutralized with dilute potassium hydroxide. The filtered solution was concentrated to a small volume, and poured into a large volume of ethanol to give an orange-red solution and a white precipitate. The precipitate was removed by filtration and dried to a fine, white powder, which amounted to 47% of the crude carbohydrate. The purified carbohydrate darkened at about 200°C. and decomposed at 260°C. It had an optical rotation of $(\alpha)_D^{20°C.} = +174°$. Although this method of purification gave a white, tannin-free carbohydrate fraction, it resulted in the loss of some polysaccharides through hydrolysis to alcohol-soluble monosaccharides. Some of the tannin appeared to be chemically combined to the crude carbohydrate product because it could not be completely removed with hide powder, or separated by fractional precipitation, but was removed after acid hydrolysis.

After complete hydrolysis, the crude carbohydrate demonstrated the presence of 54.0% reducing sugar, expressed as glucose. Maximum reducing sugar was obtained after 6 hr. hydrolysis as shown in Table V.

Paper-partition chromatography indicated the presence of glucose, arabinose, and only a trace of xylose. A pentosan determination on the crude carbohydrate gave 16.93% pentosan.

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Centrifuge Analysis for Suspended Solids in White Water

E. A. MASON and R. R. QUINCY

A rapid method for the determination of the suspended solids content of white water streams has been developed using a small hand-powered centrifuge and calibrated glass tubes. This method is recommended for use in performing routine checks on the various waste streams in pulp and paper mills and in locating the source of losses which develop. Samples of white water suspensions having known concentrations of filler and fiber were placed in glass tubes and centrifuged, two at a time. The height of the settled solids in the bottom of the tube was taken as a measure of the solids content of the original suspension. Calibration curves of this method are presented, showing the effect of tube shape, consistency, and filler-to-fiber ratio. The filler-to-fiber ratio was found to have no effect on the readings for ratios below 0.1. Even with higher filler-to-fiber ratios, a pronounced change in this ratio was required before a significant change in the calibration was achieved. The agreement between known samples and the curves presented was found to be within 5 lb. solids per 1000 gal. slurry over the range studied (0 to 80 lb. per 1000 gal.). In the application of this method, calibration curves can easily be established for the particular type of furnish employed. Once this has been done, determinations of the suspended solids content of white water can be accomplished in approximately 2 mins.

THE loss of pulp and filler from pulp and paper mills in waste white water streams can be of serious consequence. In order to determine these losses and to locate their sources, analyses of the white water streams are necessary. The analytical procedures for suspended solids recommended by TAPPI (*1*) require laboratory attention, and the necessary drying usually takes at least one day to complete. The TAPPI method of analysis is therefore not suited for on-the-spot checks of the losses from various pieces of equipment. Small holes in screens and gaskets can cause an appreciable loss in pulp and filler during the time required for the TAPPI procedure. A rapid method for the determination of the solid content of white water would therefore be of value in performing routine checks on the main waste streams in pulp and paper mills and in locating the source of losses which develop.

The use of a small hand-driven centrifuge utilizing calibrated glass test tubes has been investigated as a means of determining the total suspended solids in white water streams. The effects of consistency, filler-to-fiber ratio, and tube shape have been considered.

APPARATUS AND PROCEDURE

The centrifuge (Central Scientific Co., Cat. No. 11550) used was hand powered and was fitted with a horizontal arm holding two tubes. Two different types of tubes were used. One type (Central Scientific Co., Cat. No. 11880) held 12 ml. of fluid and was 4.5 in. long with an inside diameter of 0.5 in. The closed end tapered down to a point; this conical end was approximately 1.5 in. long. Some samples were also centrifuged in tubes (Central Scientific Co., Cat. No. 11980) having narrow cylindrical ends, 1.5 in. long, which permitted a more precise reading of the volume of settled solids when the solids content of the slurry was low. These tubes contained 6.5 ml. of liquid and were 4.5 in. long with an inside diameter of 0.6 in. at the top.

The samples for analysis were prepared by two methods. Some were prepared by taking a sample of stock from the headbox preceding a paper machine. A portion of this stock was analyzed according to the standard TAPPI procedure for total suspended solids, fixed suspended solids, and volatile suspended solids (*1*). The volatile suspended solids were assumed to indicate the pulp content, and the fixed suspended solids assumed to indicate the filler content. Other portions of the original samples were diluted in order to give samples of varying consistency. Samples of stock from three different paper furnishes were taken; in two of these furnishes talc was used as the filler, and in one titanium dioxide was used. The ratio of filler-to-fiber in the stock containing titanium dioxide was varied by the addition of weighed amounts of titanium dioxide to measured quantities of the original stock.

In the second method of sample preparation, weighed amounts of dried pulp and titanium dioxide were mixed together in beakers and stirred with an electrically driven agitator until uniform suspensions resulted.

In the case of the samples taken from the headboxes of the paper machines, the pulp had been beaten while those prepared by mixing dry pulp and filler in the laboratory had not been beaten. In all cases, bleached sulphite pulp made by an ammonia-base process was used.

Two centrifuge tubes were filled with a prepared slurry, placed in the centrifuge, and whirled at 1500 r.p.m. (approximate) for 1 min. Preliminary tests showed that no additional settling took place with a longer period of centrifuging. After centrifuging, the suspended solids lay in a dense mass at the bottom of the tube leaving the upper water layer clear. The tubes were then examined to determine whether the level of the settled solids was perpendicular to the axis of the tube. If not, the tubes were rotated in the retaining cups of the centrifuge by 180° and whirled again so that the level of the settled solids would be perpendicular to the axis. This facilitated the reading of the solids volume and increased the precision of the measurement. The total volume of the sample and of the settled solids was read using the volume markings on the containing tubes. By filling both centrifuge tubes with the same suspension of pulp and filler, duplicate analyses were run simultaneously. From

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four to ten samples of the same suspension were usually centrifuged, and the values averaged.

RESULTS

The results obtained with the 12-ml. tubes, having the conical ends, are presented in Fig. 1. The ordinate shows the concentration of total suspended solids while

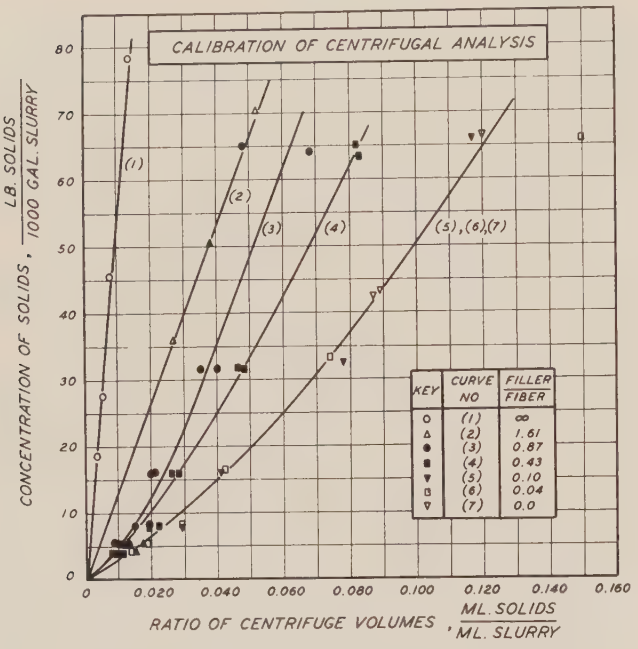
CALIBRATION OF CENTRIFUGAL ANALYSIS
CONCENTRATION OF SOLIDS, LB. SOLIDS / 1000 GAL. SLURRY
RATIO OF CENTRIFUGE VOLUMES, ML. SOLIDS / ML. SLURRY
(1)
(2)
(3)
(4)
(5),(6),(7)
KEY | CURVE NO | FILLER / FIBER
○ | (1) | ∞
△ | (2) | 1.61
● | (3) | 0.87
■ | (4) | 0.43
▼ | (5) | 0.10
⊡ | (6) | 0.04
▽ | (7) | 0.0

Fig. 1

the abscissa indicates the centrifuge readings in terms of the ratio of the volume of settled solids to the volume of the white water sample. The various curves shown are for varying weight ratios of filler-to-fiber ranging from 100% filler to 100% pulp.

The reproducibility of the experimental method proved to be very good; the 95% confidence level on the mean value for each point was found to be ±5 to 8%. Although one point on each of curves no. (3) and (6) on Fig. 1 deviates considerably from the curves, the general agreement of the data and the curves is within 5 lb. solids per 1000 gal. slurry.

It can be seen that all the lines representing suspensions in which pulp was present are slightly concave upward. The curvature is an indication that the packing becomes more pronounced as the concentration of solids in the sample increases. This is probably due to the increased pressure on the solids at the bottom of the tubes due to the added depth of solids in the tubes.

In addition to this curvature, the slopes of the lines become greater as the filler-to-fiber ratio increases. This results from the increased density of the centrifuged solids and the tendency for filler to occupy voids in the mass of fiber. This effect of filler-to-fiber ratio is not noticed below a ratio of 0.1 where samples have the same solid concentrations for a given centrifuge value. Even with higher filler-to-fiber ratios, the change in this ratio must be pronounced before a large change in the concentration of solids is achieved for a given centrifuge value. For this reason, the use of the centrifuge method should give a reasonably accurate measure of the solids content even in streams where the filler-to-fiber ratio may change slightly from time to time.

For those samples where the concentration of solids was extremely low, i.e., below 10 lb. solids per 1000 gal. slurry, there is some scattering of the data. It was very difficult to get an accurate reading of the level of the solids in the centrifuge tubes for such low concentrations of solids.

Figure 2 compares the results obtained with the two different types of tube. The packing of the solids was denser in the tubes having the small cylindrical end than in the larger tubes having the conical ends. For a given concentration of pulp the depth of solids would be greater in the former tubes, and thus the centrifugal force on the pulp at the bottom of the tube would be greater. A denser packing is thus to be expected. However, the analyses made with the tubes having cylindrical ends were not as convenient as those made with the tubes having conical ends. The pulp fibers tended to lodge at the entrance to the cylindrical section and had to be dislodged with a fine wire before they would settle to the bottom of the tubes. It is therefore recommended that tubes having conical ends be employed.

The results shown in Fig. 1 are an indication that a small hand-powered centrifuge is effective in the

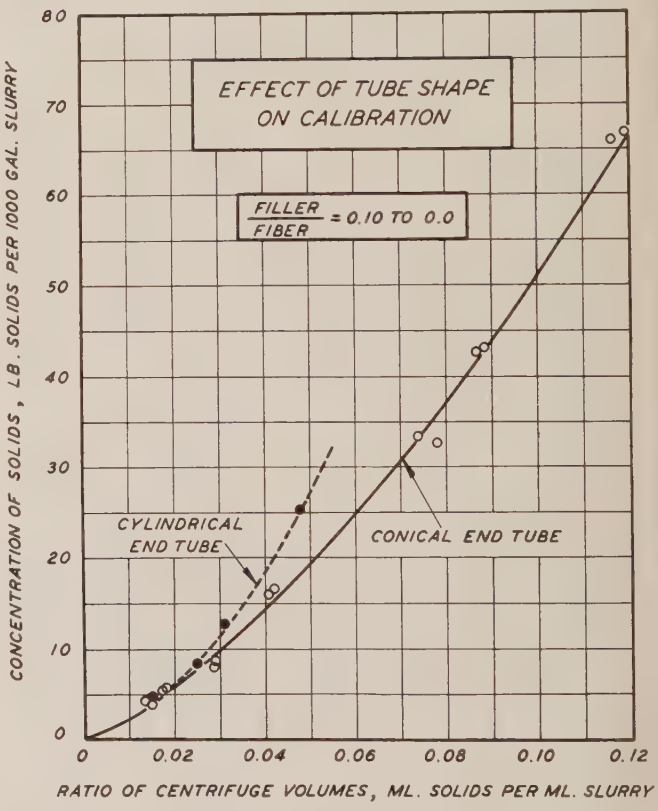
EFFECT OF TUBE SHAPE ON CALIBRATION
FILLER / FIBER = 0.10 TO 0.0
CYLINDRICAL END TUBE
CONICAL END TUBE
CONCENTRATION OF SOLIDS, LB. SOLIDS PER 1000 GAL. SLURRY
RATIO OF CENTRIFUGE VOLUMES, ML. SOLIDS PER ML. SLURRY

Fig. 2

determination of the suspended solids content of white water streams. Where an approximate value of the filler-to-fiber ratio of the stream is known, the determinations of total fixed solids should be reliable to approximately 5 lb. solids per 1000 gal. slurry. The

time of analysis is approximately 2 min. and analyses can be made on-the-spot since the centrifuge is easily portable. This rapid analysis does not replace the longer and more accurate TAPPI procedure (*1*), but it has definite advantages where time is important and particularly in trouble shooting to determine where sources of pulp leakage are occurring.

In the application of this method, calibration curves can easily be established for the particular type of pulp, furnish, and apparatus employed. Figure 1 only shows that it is possible to obtain a reproducible calibration curve when this method is used. In cases such as (1) pulp mills, (2) paper mills where the furnish contains only small amounts of filler, or (3) in paper mills when long runs on the same type of paper are made, the reliability will be higher than in those cases where the filler-to-fiber ratio is high and may vary.

SUMMARY

It has been found that the use of a hand-powered centrifuge provides a rapid determination of the suspended solids content in white water. In the range of low filler-to-fiber ratios, the effect on the determination of a variation in the amount of filler present is negligible. The use of this method is recommended where, for various reasons, a rapid determination of the solids content of white water streams is required.

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Photographic Measurement of Drainage Rate

A Method for Determining Sheetmaking Rates in Cylinder Machines

CHARLES F. PAYNE and WILLIAM E. GUTHRIE

Studies to determine the sheet-forming rate for overflow cylinder-type paper machines are difficult because of the short time involved and because of the enclosed nature of the sheet-forming section. Equipment and a method, using motion picture photography, are described for determining the drainage rate through a cylinder mold at any point during the majority of the sheet-forming interval. Knowing the white water drainage for any given point in the cylinder's rotation, the amount of web formed at this point may be calculated. The drainage test unit used duplicates the increasing papermaking head that develops as a cylinder enters the stock pond and maintains the constant head prevailing through most of the balance of the cylinder's rotation. Drainage and sheet-forming rate curves obtained for a particular single cylinder machine through use of this method are presented and proposed applications for the method are described.

On fourdrinier paper machines it is possible to obtain a fairly good idea of the time element involved in forming a paper web under various conditions merely by measurement of the white water draining through the fourdrinier wire at various points along its path from the breast roll to the couch. Studies of this particular type are, however, much more difficult in the case of the cylinder machine. The extremely short time interval involved for the entire sheet-forming cycle (2.2 sec. in the case of a 42-in. cylinder two thirds submerged on a machine running 200 f.p.m.) greatly complicates the problem and because of the enclosed construction of the sheet-forming sections, cylinder machine operators have been forced to rely rather heavily on conjecture regarding the degree of completion of a particular sheet at various points along the cylinder mold's travel. It is probably safe to say that better knowledge of the sheet-forming rate on a cylinder machine can eventually lead to developments that will improve formation, sheet uniformity (particularly as regards caliper), and printing characteristics. To the best of our knowledge, means for exact determination of this rate have not been available heretofore.

In most of the common sheet-forming systems it is recognized that by measurement of the drainage past any unit filtering area it is possible to indirectly establish the amount of web that has been deposited on that filter area during the drainage interval. In the case of an overflow-type cylinder paper machine (Fig. 1), analysis of the situation surrounding a unit wire area as it progresses through a cylinder vat indicates that, other factors being equal, this drainage must be directly affected by the hydraulic pressure, or "head," of papermaking stock on that wire area. The pressure tending to produce drainage increases from zero at point A to a maximum at point B, holds substantially at this latter level as the cylinder rotates to point C, and then diminishes practically to zero again as the cylinder emerges from the stock pond at point D. This head can be measured for a particular mold section and a plot of its value versus time for a particular cylinder situation might resemble the top line in Fig. 2. The total amount of drainage through the unit of wire area can be calculated for one complete turn of the cylinder, but the shape of curve 2, representing the actual amount of drainage that has occurred at various time intervals, is much more difficult to establish. If curve 2 can be accurately set up, then we can define curve 3,

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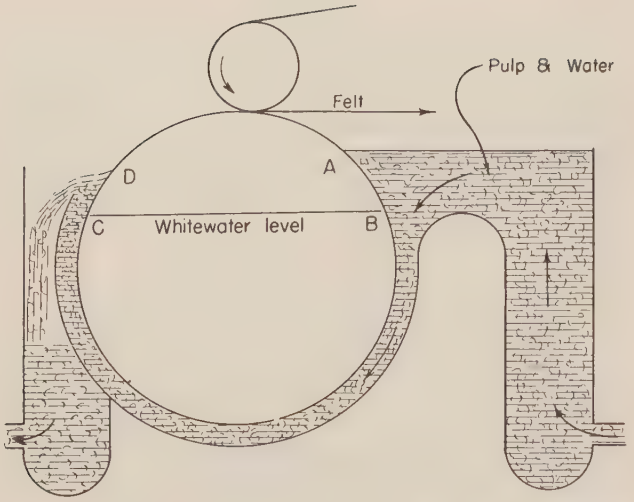

Fig. 1. Diagrammatic sketch, single-cylinder machine, overflow type

the actual amount of sheet formed at any particular point in the cylinder's travel.

It is our purpose to describe a method using motion picture photography for the determination of overflow cylinder drainage rates at any point during the majority of the sheet-forming interval.

EQUIPMENT

The primary factors influencing drainage rate as a unit wire area progresses through a cylinder vat are:

1. Consistency, temperature, slowness, and uniformity of the stock suspension.
2. Design of the screening section.
3. Head of stock over the screen area in the three phases of: (a) increasing head, (b) constant head, and (c) decreasing head.

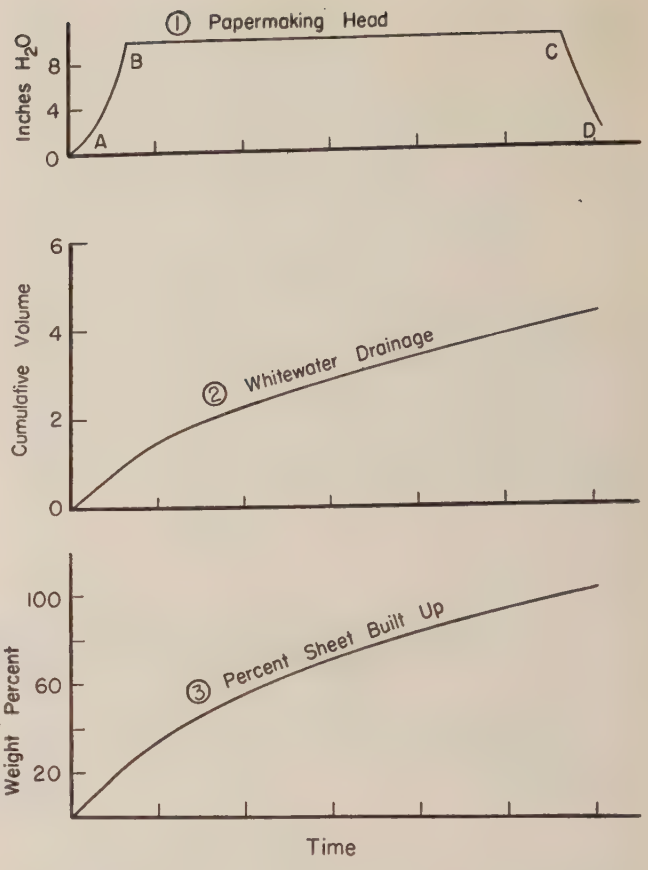

Fig. 2. Hypothetical head, drainage, and sheet-forming rate during 1 revolution of single cylinder in an overflow vat

We believe our method permits the measurement of drainage rates under the same stock and screen conditions that exist on the particular cylinder machine

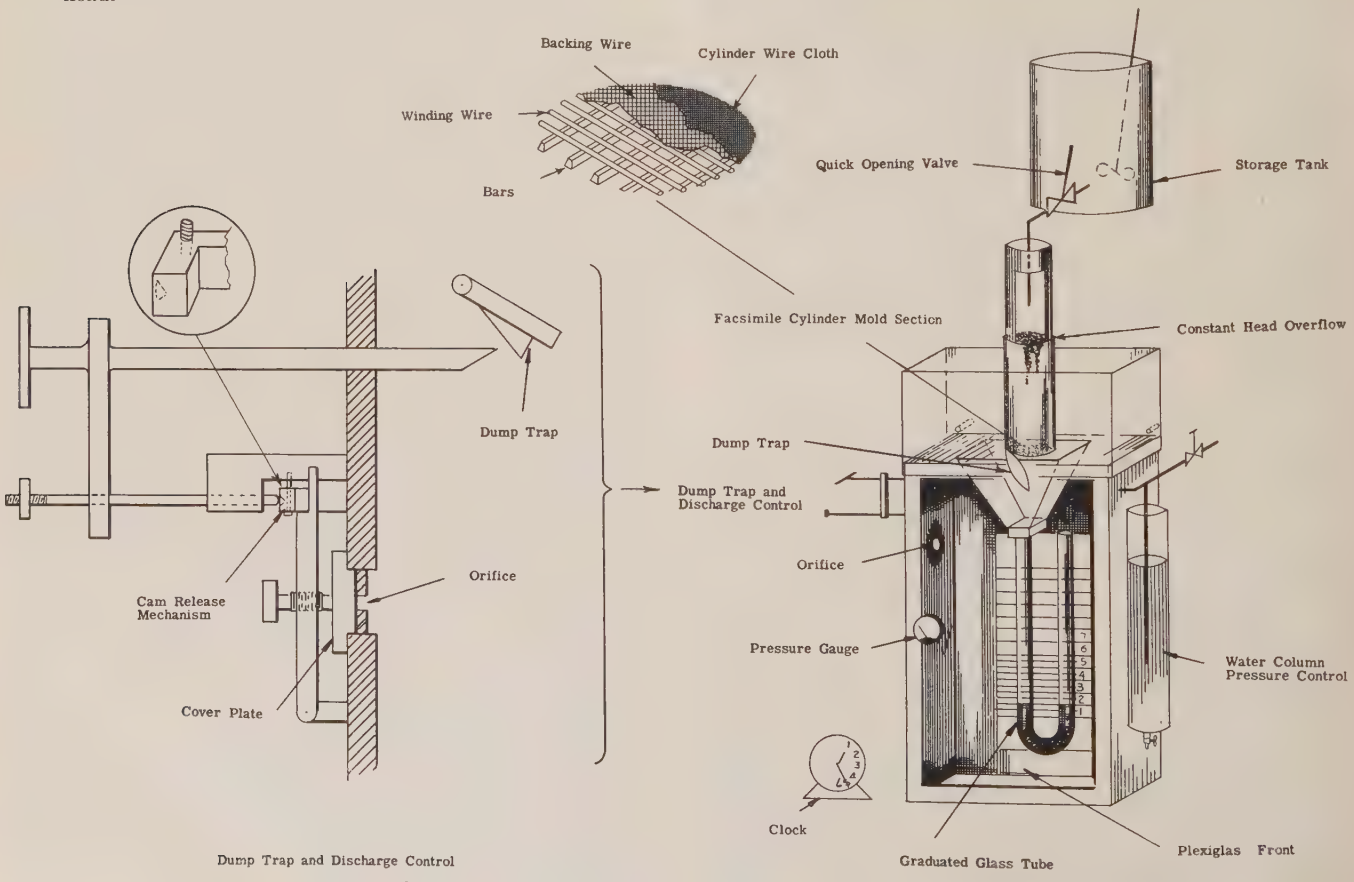

Fig. 3. Drainage test unit—diagrammatic sketch

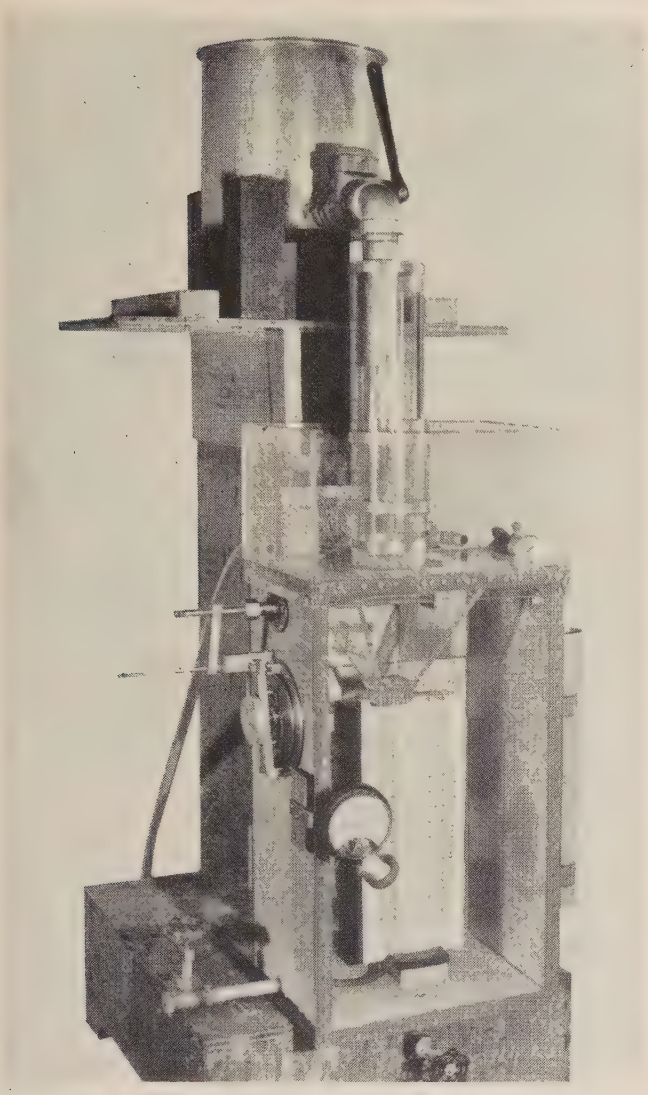

Fig. 4. Drainage test unit

under study. The equipment is so arranged as to duplicate the increasing head which prevails as the stock comes in contact with the moving cylinder mold. As the cylinder continues its rotation into the relatively constant head region, the apparatus automatically duplicates and maintains this condition throughout a time interval corresponding to the remainder of the sheet-forming cycle. No attempt has been made to reproduce the decreasing head portion of the cycle and it will later be shown that no significant percentage of the sheet is formed in this area.

The equipment, shown diagrammatically in Fig. 3, consists of a facsimile cylinder mold section in the bottom of a tubular vessel equipped with adjustable means for maintaining the constant head prevailing through the majority of the sheet-forming interval. Drainage through the wire section discharges into a graduated U tube enclosed in a transparent chamber which is under air pressure that initially equals the hydrostatic head on the wire section. The air pressure within the chamber is maintained at the desired level by continuously venting the chamber through a water column equal to the papermaking head. A mechanical linkage simultaneously opens a dump valve under the wire and a cover over a calibrated orifice in the side of the pressure chamber. As the compressed air within the chamber reduces to atmospheric pressure at a definite rate, drainage proceeds under the same increasing head condition as exists during the entry of a cylinder mold into the vat. A 16-mm. motion picture camera photographs the drainage as measured by the U tube and also "reads" a low inertia, aneroid-type pressure gage and a split-second electric clock. In order to permit easy photographic study of the drainage, and of the synchronization of the dump valve and the air discharge controls, much of the stock flow equipment is made of Plexiglas. The electric timer is a Type S-1 manufactured by the Standard Electric Time Co. of Springfield, Mass., and the pressure gage found most suitable was a Magnehelic Gage supplied by the Dwyer Manufacturing Co. of Chicago, Ill. A photograph of the complete assembly appears in Fig. 4.

The photographic setup for making the measurements during a test run is shown schematically in Fig. 5. A 16-mm. movie camera with a 64 frame per sec. adjustment is used with fine grain film, and the test equipment should be adequately illuminated by two floodlights in reflectors. In our particular work a Recordak Viewer was used to read the data frame by frame from the movie film but any magnifier could be employed.

The orifice which controls the rate of venting from the air chamber beneath the test area must be calculated and then calibrated to operate through a time interval equivalent to that existing during the cylinder's passage through the increasing head region. Knowing the cubic volume of the air chamber and the pressure differential with respect to atmospheric pressure, then the volume of air to be discharged from the orifice can be established by use of Boyle's law. The diameter of the orifice may then be determined approximately by the following relationship, detailed development of which appears as an appendix.

$$D = 3.63 \times 10^{-3} \sqrt{\frac{V\sqrt{H}}{T}}$$

T = time in increasing head region, sec.
D = orifice diameter, in.
H = inches of water represented by the papermaking head above the screening area
V = volume of air chamber, cu. in.

For a particular cylinder and head condition, these

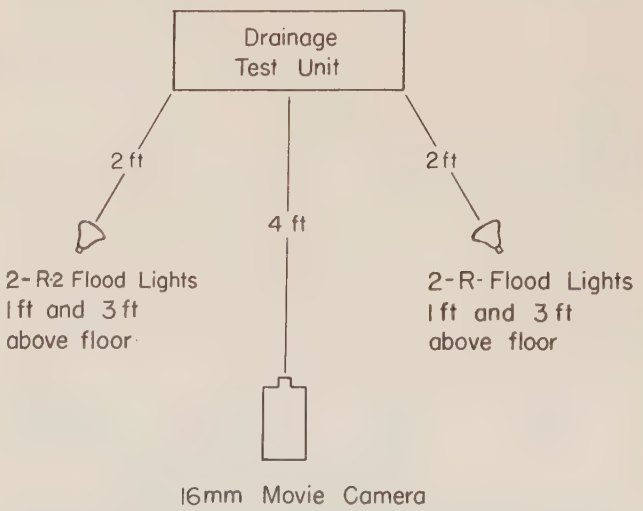

Fig. 5. Equipment arrangement for drainage test

calculations will yield the orifice diameter versus machine speed curve shown in Fig. 6.

Trial runs to calibrate any particular calculated orifice will usually reveal a difference between the time required to exhaust the chamber beneath the screen area and the actual time in the increasing head region for the particular cylinder machine being studied. It can be surmised that this discrepancy is probably due to: (1) use of an inaccurate orifice coefficient, (2) failure of the equipment to establish ideally free discharge at the beginning of the venting operation, (3) low scale inertia effects on the pressure gage.

PROCEDURE

To make a test run the supply tank above the constant head chamber is filled with stock taken as close to the cylinder vat as possible. This stock is kept in suspension by a mixer and its temperature is maintained at the paper machine level. Enough water containing a little dye is added to the U tube to fill the bottom of the tube. The air pressure beneath the wire section is adjusted to equal the hydrostatic head above the wire (and the papermaking head) by means of a variable water column on the air supply. The movie camera is started by one operator while a second man opens the stock supply valve. When stock flows from the constant head discharge the dump valve and air discharge control is tripped by the second operator. As the air pressure beneath the wire reduces, drainage commences and continues through the constant head interval. At the end of a total interval equal to at least one cylinder revolution, the camera is stopped, the equipment drained and reset for a check run. Runs may be made with stocks of other slownesses, consistencies, or heads, to note their effect on sheet-forming rates.

COMPILATION OF DATA

After the movie film has been developed the data are read frame by frame through a magnifier and recorded as total drainage versus time. Figure 7 shows a pair of drainage curves for a particular 42-in. cylinder operating under different papermaking heads, but with identical stock furnish, slowness, and consistency. It will be noted that for the stock studied, drainage is practically negligible by the time the cylinder emerges from the constant head phase of its cycle, thus justifying our failure to recognize the final decreasing head portion of the cylinder travel.

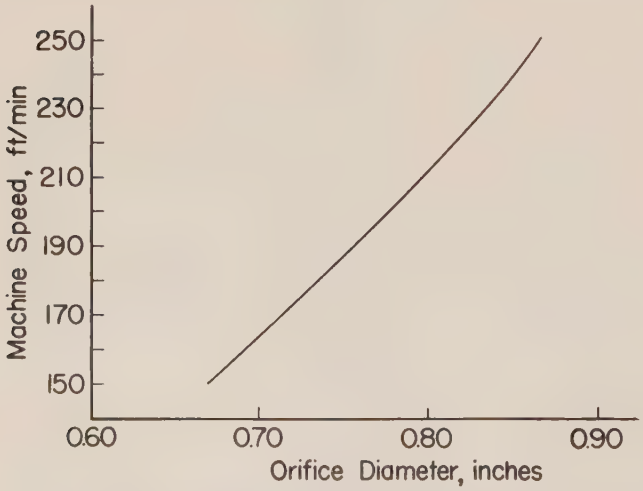

Fig. 6. Orifice diameter versus machine speed—9-in. papermaking head, 42-in. diam. cylinder 68.5% submerged

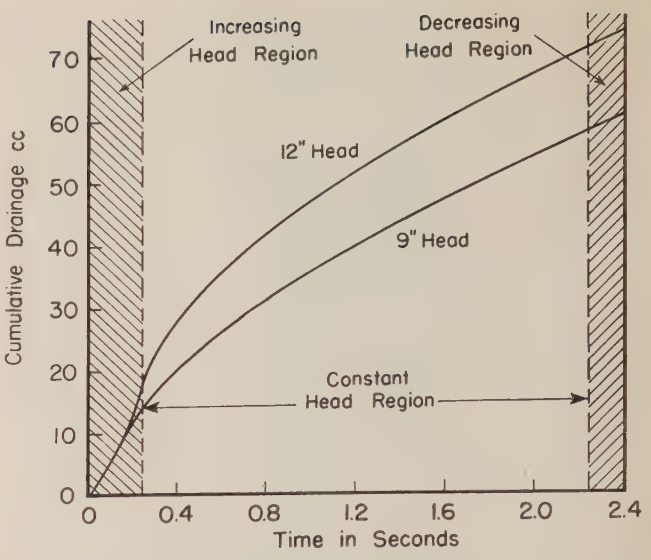

Fig. 7. Cumulative drainage versus time—42-in. cylinder 68.5% submerged; 188 f.p.m. machine speed; Canadian Standard freeness 115 ml.; entering consistency 0.87% moisture-free

APPLICATIONS

Knowing the drainage characteristics for a unit cylinder area as it passes through a cylinder vat, the percentage of total sheet formation existing at any particular point in the cylinder's travel can be calculated directly. A typical plot of data for a given stock for a particular cylinder is shown in Fig. 8, with the indicated percentage of total sheet that had formed at the end of successive 0.1-sec. intervals superimposed on a diagram of the overflow vat under consideration.

Another application for this drainage measuring method will be found in the determination of the decreasing volume of stock in the annular space between the cylinder and vat circle for overflow vats. Knowing this decreasing volume for various points along a vat circle the average stock velocity can be calculated for

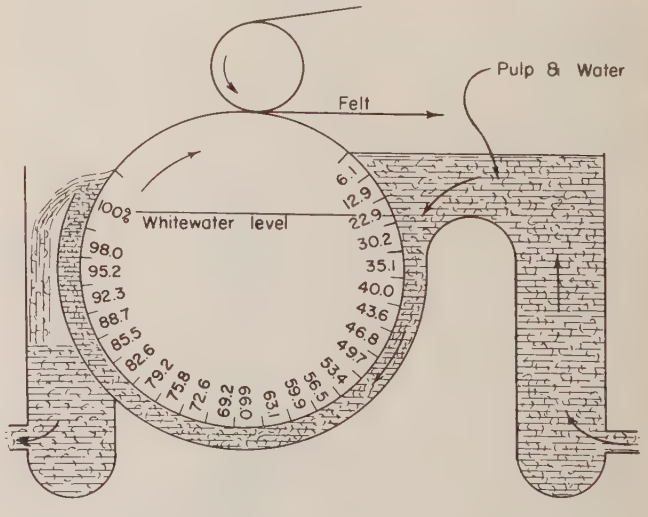

Fig. 8. Percentage of sheet built up during 0.1-sec. intervals—9-in. papermaking head; 42-in. cylinder 68.5% submerged; 188 f.p.m. machine speed; Canadian Standard freeness 115 ml.; entering consistency 0.87% moisture-free

these same points and, if desired, the data may be used for design of vat circles producing definite stock velocity relationships with respect to the moving cylinder molds.

It is hoped that with the drainage measuring method here presented, better general understanding of sheet-forming rates on cylinder machines may be developed, and that improvements in design may eventually result.

APPENDIX

The general equation for the free flow of air from a large chamber under constant pressure through a square-edged orifice is derived below.

Symbols

C = orifice coefficient = 0.60 for a square-edged orifice $^1/_{16}$ in. thickness
A = area of orifice, sq. ft.
μ = air velocity, ft./sec.
Q = air flow rate, cu. ft./sec.
g = 32.2, ft./sec.^{2}
h = gage pressure, ft. of air
p = gage pressure, in. of water
ρ = density of air, lb./cu. ft. = 0.075 at 70 °F.
D = orifice diameter, in.

$$Q = CA\mu \tag{1}$$

Since $\mu = \sqrt{2g\Delta h}$, the above equation now becomes

$$Q = CA\sqrt{2gh} \tag{2}$$

$$h = p \times \frac{14.7 \text{ p.s.i.}}{406 \text{ in } H_2O} \times \frac{144 \text{ sq. in.}}{\text{sq. ft.}} \times \frac{1}{\rho}$$

$$= p \times \frac{14.7 \times 144}{406 \times 0.075} = 69.5p$$

Substituting in equation (2) above, we obtain

$$Q = CA\sqrt{2 \times 32.2 \times 69.5p} \tag{3}$$

$$= 66.9CA\sqrt{p}$$

$$A = \frac{\pi}{4}\left(\frac{D}{12}\right)^2 = \frac{3.14D^2}{4 \times 144}$$

Substituting in equation (3) above, we obtain

$$Q = 66.9 \times 0.60 \times \frac{3.14D^2}{4 \times 144}\sqrt{p}$$

$$Q = 0.218D^2\sqrt{p} \tag{4}$$

Equation (4) is the general equation for constant pressure discharge. Since the pressure is not constant in this particular case, but will duplicate the increasing head condition found in the first phase of a cylinder's rotation, it is necessary to integrate the general equation over the full range of the papermaking head, as follows:

T = time to exhaust air chamber, sec.
V = volume of air chamber, cu. in.
H = initial air chamber gage pressure, in. of H_2O—papermaking head
H_o = final air chamber gage pressure, in. of H_2O
D = orifice diameter, in.
Q_x = flow rate through orifice at t_x, cu. ft./sec.
P_x = in. H_2O absolute pressure in chamber at given time t_x
t_x = time when pressure = P_x, sec.
v_x = volume of free air in chamber at P_x and t_x, cu. in.

According to Boyle's law,

$$v_x = V\frac{P_x}{406}$$

where 406 in. H_2O = atmospheric pressure of 14.7 p.s.i.

Differentiating with respect to P_x, we obtain

$$\frac{dv_x}{dP_x} = \frac{V}{406}\frac{dP_x}{dP_x}$$

$$dv_x = \frac{VdP_x}{406}$$

Differentiating with respect to t_x, we obtain

$$Q_x = \frac{dv_x}{dt_x} = \frac{VdP_x}{406dt_x}$$

Converting V to cubic feet, we obtain

$$Q_x = \frac{(V/1728)dP_x}{406dt_x} = \text{cu. ft./sec.} \tag{5}$$

Since $Q = 0.218D^2\sqrt{p}$ (equation (4) above), and $p = P_x - 406$
Therefore

$$\frac{(V/1728)\,dP_x}{406dt_x} = 0.218D^2\sqrt{P_x - 406}$$

and

$$dt_x = \frac{(V/1728)\,dP_x}{0.218D^2(406)\sqrt{P_x - 406}} = \frac{6.54 \times 10^{-6}\,VdP_x}{D^2\sqrt{P_x - 406}} \tag{6}$$

Integrating equation (6) between the limits of O and T, we obtain

$$\int_{t_x=0}^{t_x=T} dt_x = \frac{6.54 \times 10^{-6}\,V}{D^2}\int_{P_x=H_o+406}^{P_x=H+406}\frac{dP_x}{\sqrt{P_x - 406}}$$

$$[t_x]_o^T = \frac{6.54 \times 10^{-6}\,V}{D^2}\left[\frac{\sqrt{P_x - 406}}{1/2}\right]_{H_0+406}^{H+406}$$

$$T = \frac{1.308 \times 10^{-5}\,V}{D_2}\left[\sqrt{H} - \sqrt{H_o}\right]$$

$$D = \frac{\sqrt{1.308 \times 10^{-5}\,V\sqrt{H}}}{T}$$

(since H_o = atmospheric pressure = 0 in H_2O gage), or,

$$D = 3.63 \times 10^{-3}\sqrt{\frac{V\sqrt{H}}{T}}$$

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"Fan Engineering," 5th ed., pages 117 and 118, published by Buffalo Forge Co., edited by R. P. Madison.

Received Aug. 26, 1952. Presented at the Seventh Engineering Conference of the Technical Association of the Pulp and Paper Industry, Chicago, Ill., Oct. 13–16, 1952.

ADDENDA

The method devised by Payne and Guthrie for experimentally determining the sheetmaking rate on cylinder machines appears to have very considerable merit.

However, if my interpretation of their *modus operandi* is correct, the conditions under which flow through the wire in the cylinder mold occurs are not duplicated in the apparatus they describe, and I therefore think it unlikely that the results obtained in their experiments can be usefully applied to the design of cylinder machine vats, unless the apparatus is modified.

Referring to Fig. 1 in zone A-B formation takes place under uniformly increasing head, and in zone B-C under substantially constant head, and Mr. Payne

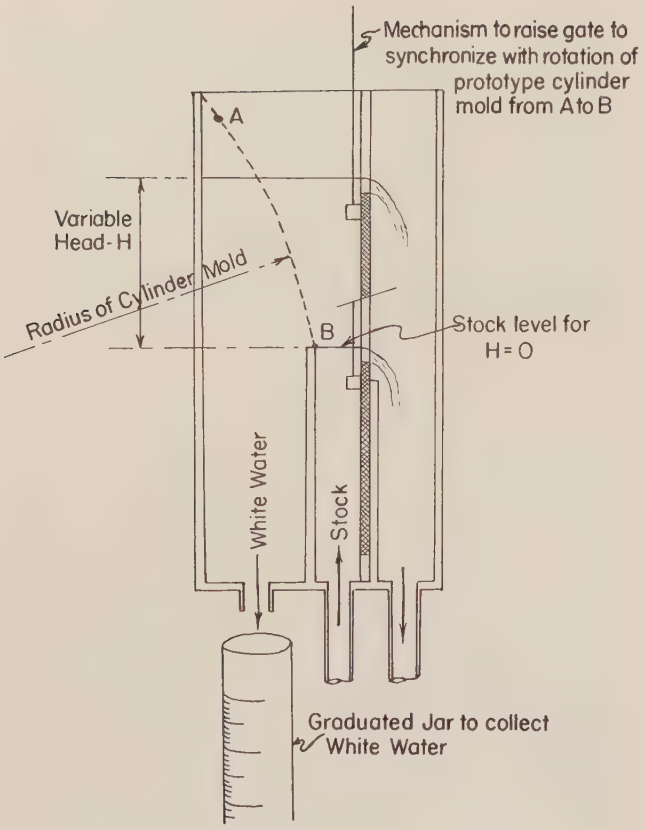
Mechanism to raise gate to synchronize with rotation of prototype cylinder mold from A to B
A
Variable Head-H
Radius of Cylinder Mold
B
Stock level for H=0
White Water
Stock
Graduated Jar to collect White Water

Fig. 9

has attempted to duplicate these conditions in his apparatus. Unfortunately he seems to have overlooked the fact that in the principal forming zone, B-C, the wire is completely submerged and flow takes place through the wire from water to water, whereas in zone A-B flow is from water to air. It can be observed by studying cylinder machines in operation, and, more clearly, by looking at deckers and Bird screens, that there is very little flow through the wire, or plates (in the case of Bird screens), in zone A-B. This, of course, is due to the low coefficient of discharge which pertains under this condition of flow from water to air.

Due to the effect of surface tension and to the very pronounced *vena contracta* that forms in flow of a fluid through an orifice under this condition, very little white water actually passes through the wire in a cylinder vat in zone A-B, and therefore very little sheet formation can take place in this zone. This was clearly shown by Goldsmith in the paper he presented to TAPPI in 1938. In Fig. 6 on page 131 of *Tech. Assoc. Papers*, 21, No. 1, (1938), Goldsmith gives a curve which, I think, is a very close approximation to the normal rate of sheet formation on a cylinder mold. I think that Payne's apparatus approximates to the actual rate of formation in this zone, but probably not as closely as might be done if his apparatus was modified along lines which I shall describe later.

In zone B-C, however, I think that the results he obtains are liable to be quite inaccurate, as, if my interpretation of the operation of his apparatus is correct, there is an air space between the under side of the wire and the surface of the water in the U tube which collects the water that has drained through the wire. I think that results more closely approximating actual conditions would be obtained if he determined the rate of sheet formation in the two zones independently.

For the determination of rate in zone A-B, I would suggest that an apparatus be made up roughly in accordance with Fig. 9. In this apparatus the element of wire on which formation occurs would be curved to a radius corresponding to that of the cylinder mold on which the drainage is being investigated. In actual operation in the cylinder machine vat, a given point on the wire enters the surface of the stock and travels downward under increasing head from A to B. These results can be simulated by holding the wire stationary and increasing the head from A to B, as shown in Fig. 9. If the white water flowing through the wire under these conditions was collected in a graduated jar and photographed along with a clock, by the method already devised by Mr. Payne, I think that the actual conditions of formation in zone A-B would be closely approximated, and the rate and amount of formation in this zone could be easily evaluated.

For the experimental determination of the flow through B-C, I would suggest an apparatus shown diagrammatically in Fig. 10. In this apparatus, the wire through which drainage takes place would form the bottom of a box in which the stock would be held at a constant head, H, corresponding to the constant head prevailing over the zone B-C in the cylinder machine vat. At the start of the experiment, the space below this wire would be filled with water so that the wire was just barely submerged. During flow under constant head conditions, white water flowing through the wire would be collected in a graduated jar and photographed,

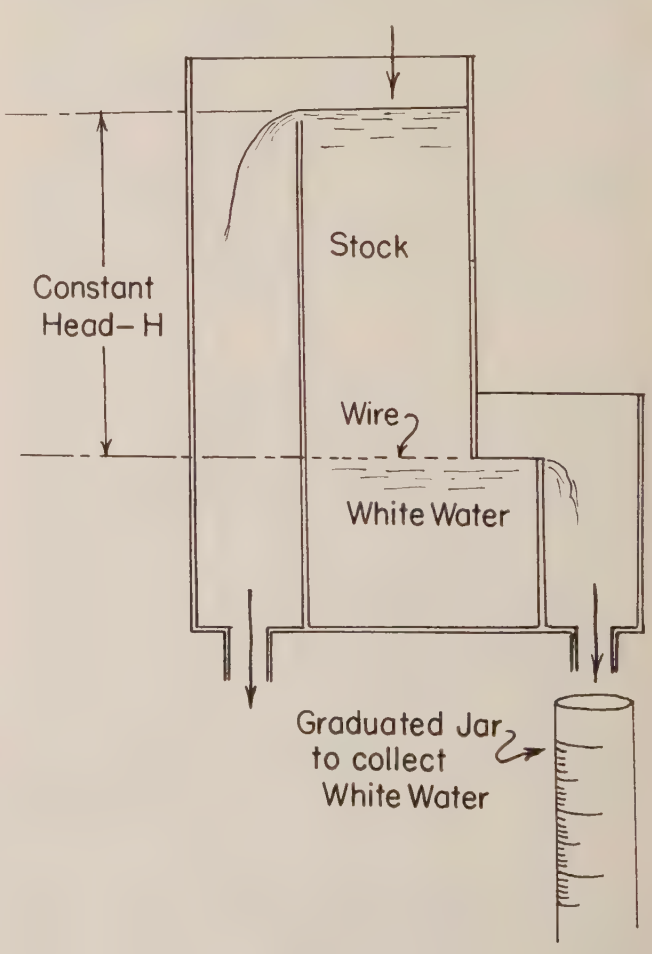

Fig. 10

along with the clock, over a period of time long enough to simulate the travel of a point on an actual cylinder mold from the beginning to the end of zone B-C.

The results thus obtained, when correctly evaluated, should give a very close approximation to the actual sheet formation conditions, under conditions of total wire submersion such as actually obtain in a cylinder machine vat.

A. Cunningham
Price Bros. & Co., Ltd.

We are much obliged to you for your comments on our paper, "A Photographic Measurement of Drainage Rate." Mr. Lyall forwarded your letter to us before the meeting last October to enable us to prepare an answer to your thought-provoking comments. During the design of our apparatus we had considered the very question which you presented, that is, the difference in coefficient of discharge through an orifice from liquid phase to liquid phase versus liquid phase to gas phase. We made a literature search on this question and could find nothing which showed any difference in the range of Reynolds numbers in which we were operating, so we considered the difference, if any, to be insignificant. However, when you presented the problem to us again, we decided that it would be best to obtain experimental evidence to either verify or disprove our assumption.

Assuming that our apparatus duplicated the hydraulic conditions existing in zone A-B on the cylinder machine (Fig. 1) we redesigned it to duplicate the conditions existing in zone B-C, where the system is draining from a water phase through the wire to a water phase. A diagram of the redesigned apparatus appears

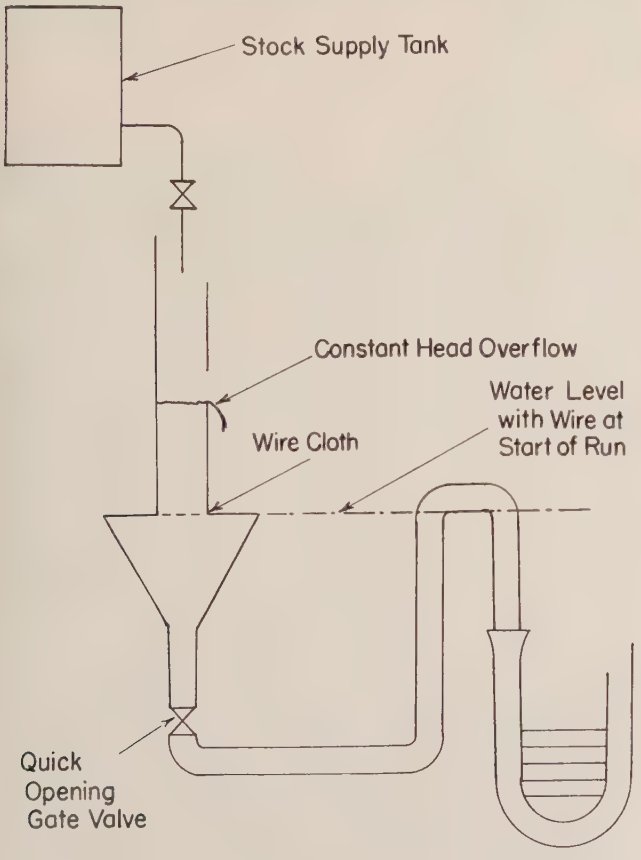

Fig. 11

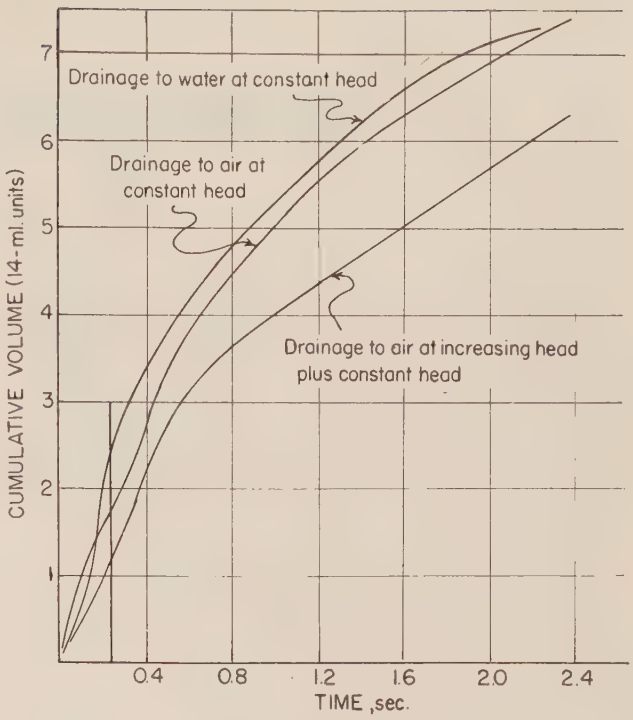

Fig. 12

as Fig. 11. Using the same furnish in our original apparatus and in the redesigned apparatus and operating at the same constant hydraulic head in both cases we obtained the drainage curve which is shown in Fig. 12. As you can see these curves are quite similar and we believe even better results could be obtained if we had the time to obtain more data. Both of these curves are the average of six separate drainage tests on each piece of apparatus. In order to check our results even further we again used the same furnish and made a series of drainage tests on our original apparatus, duplicating cylinder machine conditions as nearly as possible. Using the drainage curve obtained from these latter tests we calculated the theoretical moisture-free weight of the pad deposited on the wire cloth in our apparatus and found this weight agreed exactly with the moisture-free weight of the sheet made on the paper machine from the same furnish. These results lead us to believe that our apparatus successfully duplicates the cylinder machine operation.

The apparatus you suggest is very ingenious and we believe it would duplicate the increasing head region in zone A to B very well but the method of synchronizing the gate with the rotation of a prototype cylinder over a range of machine speeds might prove to be a problem in itself. We do not believe that the second portion of the apparatus would duplicate the drainage in the constant head region because the initial pad would be formed at a constant hydraulic head, and this is not the condition existing on the paper machine under study. The initial pad is already formed when the cylinder encounters the constant head region and in this region the pad and not the wire is the controlling drainage factor.

Charles F. Payne and William E. Guthrie
Eastman Kodak Co.

An Evaluation of Drying Concepts

A. J. CIRRITO

Factors governing heat transfer inside paper driers are analyzed. The influence of shell rotation on the steam-side coefficient is discussed with reference to the application of heat transfer data from other fields. Steam-side resistance in paper driers operating at both low and high speeds is found to be of appreciable magnitude. The effects of vapor velocity and noncondensable gases are described. Recommendations are made for improving operating techniques with existing equipment, and for promoting better design of new equipment.

IN PAPERMAKING, the best and cheapest method of increasing production has been to improve existing machines. At the wet end higher speeds had to be developed through costly experimentation on actual machines, with corresponding production loss. The dry end, on the other hand, was adapted for increased production by the simple expediency of adding driers or using higher steam pressures. Only small improvement has been made to the drying process since the drying problem's many factors must be carefully correlated to avoid sacrificing sheet quality to obtain higher machine speeds.

The problems of paper drying may be considered from three major aspects: (1) factors governing heat transfer inside the drier, (2) factors governing heat and mass transfer outside the drier, and (3) the relationship of heat and mass transfer to machine speed and sheet quality.

Because our studies have been concentrated extensively on factors governing heat transfer inside the drier, we shall discuss this phase exclusively.

HEAT TRANSFER ANALYSIS OF PAPER DRIERS

The usual method for analyzing heat transfer in paper driers involves, first, the measurement of heat transfer rate and steam temperature for the entire machine. Then, a mean coefficient for the sheet side is calculated on the basis of a mean evaporating temperature, the shell thickness, and conductivity, and the assumption of a steam-side film coefficient of 2000 B.t.u. per (sq. ft.) (hr.) (°F).

The results so obtained, however, are misleading and inaccurate. The sheet-side coefficient is affected by a number of factors, including moisture content, contact pressure, sheet thickness, etc., which vary throughout the machine. For this reason, each of these factors cannot be accurately reflected by a mean coefficient for the entire machine. The usual concept is that the major resistance to heat transfer lies on the outside of the drier, and therefore, improvement of the inside coefficient is of limited value. Most of us are acquainted with observations from practice which indicate that this concept is open to question.

On driers with heavy end plates, the edges of the sheet are sometimes overdried, probably because of the additional heat flow to the sheet through the end plates. It is not likely that this would occur if the steam-side resistance were negligible. As early as 1937 Chambers (*1*) recognized that an appreciable film of water is carried around with the drier and causes a large temperature drop from steam to shell surface. Montgomery (*2*) reported in 1946 and others, more recently, that in some cases, nonuniform drying results where blow-through steam is used or increased. If the steam-side resistance were negligible, this effect would not appear, and there would be no reason to expect improvement through increased steam velocity. At the wet end of the drier section the evaporation rate is relatively high and the sheet-side resistance must, of necessity, be correspondingly low.

A steam-side coefficient of 2000 is generally accepted in the design of commercial shell and tube heat exchangers. The application of this value to the paper drier is probably based on the supposition that conventional siphon systems, both fixed and rotating, remove condensate to a degree comparable to drainage from a small tube in a commercial exchanger. There is ample reason to suspect that the steam-side coefficient in a paper drier can be considerably less than 2000 and is not necessarily constant from machine to machine or from drier to drier within the machine. If this is true, the assumption of a constant steam-side coefficient gives a distorted value for the outside coefficient.

HEAT TRANSFER IN A STATIONARY CYLINDER

Nusselt (*3*) derived a relationship from a consideration of fluid dynamics of the condensate film, its resistance to heat flow, and the rate of condensation, which has proved basically sound and is used for the design of most commercial equipment. Thus, our first step was to consider the condensation of steam inside a stationary shell using the Nusselt equation for the determination of the heat transfer coefficient, and to compare the results with field data on a paper drier. This drier, 5 ft. in diameter by 200-in. face, drying 42-lb. kraft at 700 f.p.m. with saturated steam at 320°F., was found to condense 1785 lb. per hr. The heat flux in this drier is calculated to be 6100 B.t.u. per (hr.) (sq. ft), based on the total drier surface. Applying the Nusselt equation to a stationary shell of this size, operating under the same steam conditions and same heat flux, the film coefficient is calculated to be 1361 B.t.u. per (hr.) (sq. ft.) (°F.), and the film-temperature drop is 4.5°F. The mean thickness of the condensate film in the stationary shell is calculated to be 0.0042 in. This film thickness, derived from a balance of forces exerted on the film is required to give adequate drainage of the condensate down the shell wall. It is much thicker than the rate of deposition which, in the paper drier mentioned above, amounts to only slightly over 0.001 in. per revolution.

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A drier condensing at a rate greater than the average for a machine was selected to show that even a large drying rate deposits a film of negligible thickness per revolution. If we considered a stationary drier operating with one half the above condensing rate, we would find that the mean film thickness (and therefore the resistant to heat flow) would decrease only about 10%, but the film-temperature drop would decrease appreciably. It should be emphasized that the Nusselt equation was derived for heat transfer on stationary surfaces. From a close examination of the fluid dynamic considerations, it is apparent that the Nusselt equation is not directly applicable to the case of a rotating shell.

CONDENSATE FILM IN A ROTATING CYLINDRICAL SHELL

In the case of a slowly rotating shell the film thickness is expected to exceed that existing in the static shell. Further, it is inconceivable that present-day siphoning mechanisms can reduce the condensate film to the thickness indicated by the Nusselt equation. Recognizing this fact, the next step was to analyze the film conditions in a rotating shell purely from fluid dynamic considerations.

The fundamental relationship for a noncompressible fluid in laminar flow past a solid surface equates the shearing stress in the fluid to the product of its absolute viscosity and the velocity gradient across the laminar film. In film wise condensation, which normally exists in a drier, the layer of fluid adjacent to the shell is considered to have the same velocity as the shell. Starting with this relationship and the equilibrium which exists between gravitational and viscous forces, the equation (*4*) for the mean velocity of the fluid was developed:

$$V_m = \frac{\gamma}{3\mu} Y^2 \sin \phi$$

where

Y is the thickness of the film in feet
μ is the absolute viscosity in (pound force) (second) per (square foot)
V_m is the mean velocity in feet per second
γ is the specific weight in pounds per cubic foot
ϕ is the angle defining the component of the specific weight around the cylinder

Nusselt used this relationship in deriving the film coefficient for condensate flowing down a stationary wall. Figure 1 illustrates the accumulation of condensate as its flows down the sides of a stationary shell. For a given thickness and angle ϕ, the mean velocity of the film with respect to the shell may be calculated. For this same thickness, the velocity is greatest when ϕ is 90°; when ϕ is zero, the velocity is zero.

There are also inertia forces which act on the flowing condensate. These and pressure forces have been omitted since they are relatively small (*5*) and because they involve a complex mathematical solution beyond the scope of this paper. The simplified equation may be used in a preliminary way, however, to examine what is happening in a rotating shell. The numerical results, though approximate, are of representative order.

We must assume at first that the shell is stationary and that the fluid is flowing down the wall, as in Fig. 1. If the thickness of the fluid at angle $\phi = 90°$ is 0.009

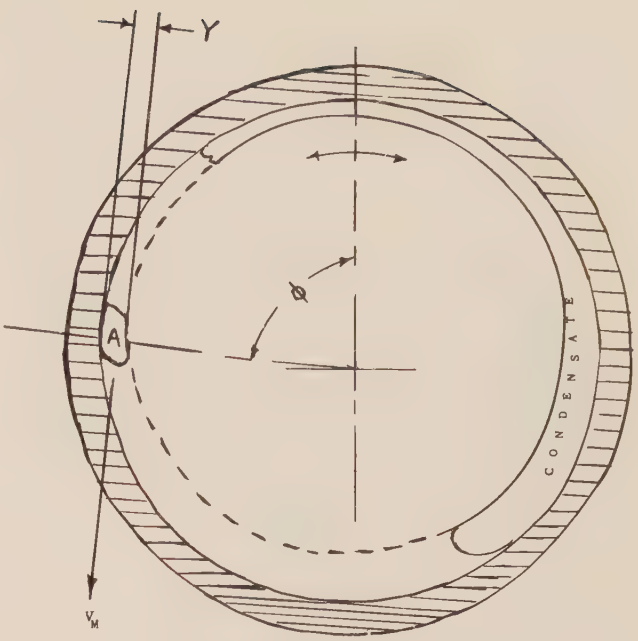

Fig. 1. Stationary shell

$$V_m = \frac{\gamma}{3\mu} Y^2 \sin \phi$$

in., its mean velocity is calculated to be 173 f.p.m. Now consider the shell rotating in clockwise direction counter to the natural fall of the fluid (Fig. 2) at a speed of 174 f.p.m. From an examination of the velocity gradient at the 90° position, we can locate the point on the curve where the velocity of the fluid is 175 f.p.m. with respect to the shell. A particle of fluid at this point is fixed with respect to a point in space. All the fluid on the shell side of this point flows upward, and all that to the right flows downward. The velocity distribution is taken as parabolic and the mean velocity in this case is two thirds of the maximum. The maximum velocity difference between fluid and shell is calculated to be 261 f.p.m. If the film thickness were maintained at 0.009 in. and the shell speed increased to 261 f.p.m. all the fluid would start to flow upward. As the fluid flows upward above the 90° point it increases in velocity, because the gravity component along the shell decreases. In order to satisfy the requirements of continuity, the film thickness decreases as the fluid velocity around the cylinder increases for a fixed shell speed.

From an examination of the equation, it can be seen that for the same fluid properties and angle ϕ, the sustained thickness increases with the velocity. For example, at a shell speed of 700 f.p.m., the thickness is calculated to be 0.018 in. Below rimming speeds most of the fluid in this film is carried up from the pond; condensation contributes only a small amount. In a stationary shell, the film builds up through condensation until the drainage rate within the film balances the rate of condensation.

The 90° position was selected because it is the location where the film coming up from the pond first encounters the full effect of gravity. Below this point progressively thicker layers can be supported at any one shell speed. As the film moves up beyond this point it must depend on adhesion and centrifugal force for support in the upper quadrants. Large layers of

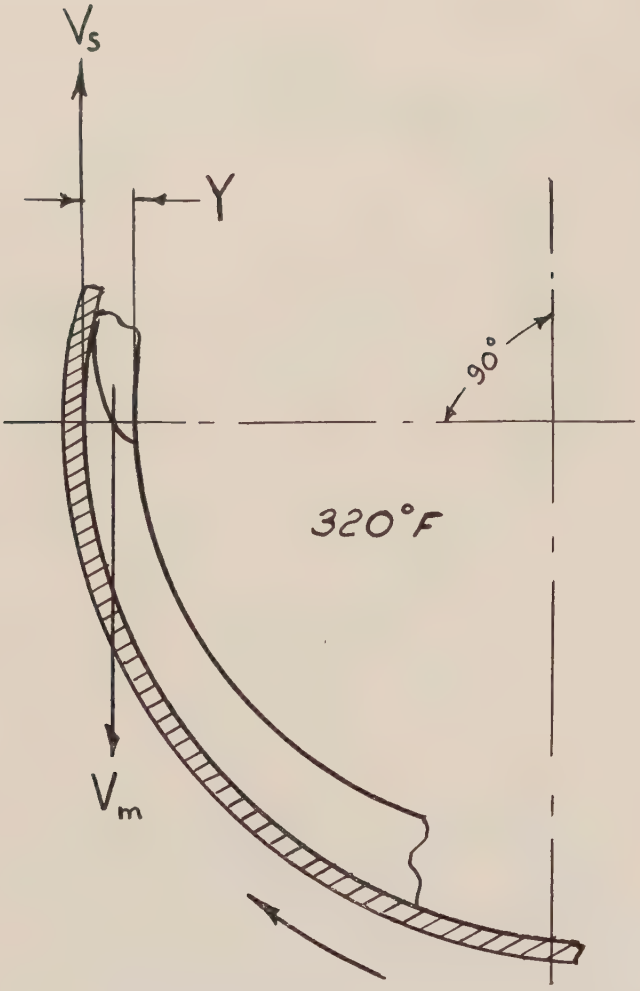

Fig. 2

$$V_m = \frac{\gamma}{3\mu} Y^2 \sin \phi$$

water collapse in the upper left-hand quadrant in the speed range just below the critical speed for rimming. These cause power surges which make operation impractical in the subcritical range.

This analysis indicates that the thickness of the film that can be supported increases with shell speed, and even relatively small shell velocities can support films of appreciable thickness. The effect of pond depth has not been considered; the analysis is applicable, however, when the residual condensate is a small quantity. When ponds are somewhat in excess of what is generally expected from good conventional siphons, the same parameters function, but in a more complex manner.

It can be deduced from the experiments by Dominion Engineering Co. (*4*) on rimming condensate that a similarity exists in the two cases. It is reasoned that the condensate will rim because the viscous forces operate to move more liquid with increased speed. A simple

Table I. For 60-in. Dia. Drier

H_s	*Depth of pond, in.*	*Thickness of film, in.*	*Volume, cu. in./in.*
190	0.60	0.030	5.47
285	0.42	0.020	3.65
570	0.25	0.010	1.82
714	0.18	0.008	1.46

$H_s = \frac{K}{L}$ where K for H_2O is 5.7 B.t.u./(hr.) (ft.²) (°F. 1 in.).

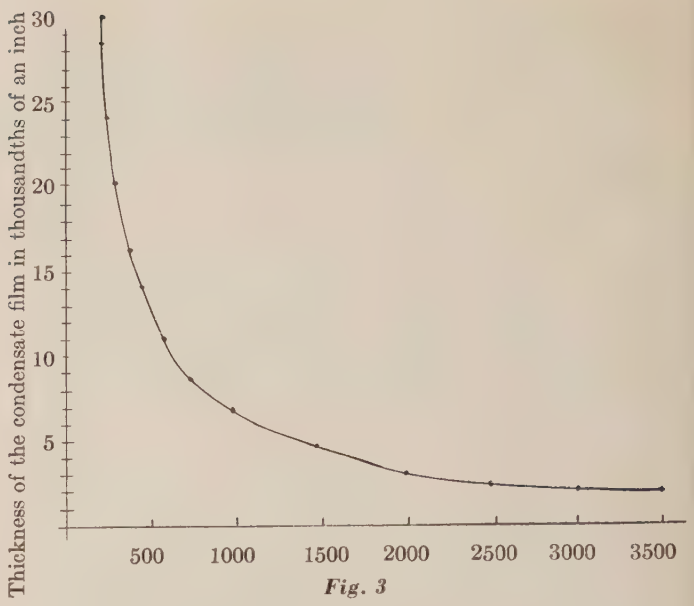

Fig. 3

Film coefficient H_s in B.t.u./(sq. ft.) (hr.) (°F.)

experiment can be performed with a glass jar showing that a definite film adheres to the surface and carries around at all significant speeds.

As a matter of interest, Table I and Fig. 3 show the depth of static pond corresponding to film thickness for the same volume of water uniformly distributed around the entire periphery of a 60-in. diameter drier. It is evident from these examples that it takes only a small quantity of water to coat the drier with a substantial film. The graph in Fig. 3 shows coefficients for films of various thicknesses calculated on the basis of pure conductivity. A film thickness of 0.003 in. would yield a coefficient of 2000; 0.008 in., a coefficient of 750; 0.016 in., a coefficient of 375, and so on. Transfer coefficients for films with high velocity gradients are higher than those on the graph and would have to be corrected for some experimentally determined function of Reynolds' number (*7*). The ones shown are consistent with Nusselt's theory for viscous flow and low steam velocities. For this range, experimental data on commercial heat exchangers indicate actual coefficients to be 10 to 20% higher than the theoretical values.

HEAT TRANSFER THROUGH RIMMING CONDENSATES

So far, the studies are concerned with condensate films at relatively low speeds. The next procedure was to consider heat transfer for conditions where all the condensate rotates with the drier.

At high speed, conventional siphons can reduce the condensate layer to approximately $^3/_{32}$ in. The nature of transfer under this condition is difficult to analyze because of numerous dynamic factors which must be taken into account. Owing to the temperature gradient across the layer, centrifugal force acts to hold the dense fluid next to the shell. The possibility of free convection currents in the fluid is remote because of the relatively high angular velocity of the shell and fluid. Some convection currents are set up at the surface, on the other hand, by the flow of the condensate to the siphon. Vapor velocities of appreciable magnitude are considered to supplement this effect by shearing

the surface. Still another disturbance is caused by the fact that the gravitational distribution of the mass is unsymmetrical around the center of rotation and shifts with every revolution. The magnitude of the effect of all these factors is unknown. Our conjecture is that they create enough agitation to induce convection currents such that moderate differences in depth will have a negligible effect on the transfer. There is some indication of this from experiments conducted in Lukenweld Development Laboratory. These experiments were performed primarily to evaluate the pressure drop necessary to remove condensate with a rotating siphon, and were not refined enough for accurate heat transfer studies. In any case, the heat transfer resistance can be appreciable and designers should gear their efforts toward reducing it. An investigation of the nature of a thick condensate layer may lead to the improvement of current installations.

THE EFFECT OF NONCONDENSABLE GASES ON HEAT TRANSFER

Uniformity of heat transfer can be seriously impaired and the coefficient reduced by the presence of noncondensable gases and/or a poorly oriented steam path. If the supply of steam is adequate and unrestricted, it will flow immediately to the cold surface replacing the condensed vapor. As steam is condensed, noncondensable gases in the steam are released on the cold surface and present a resistance to the flow of steam to the surface. Othmer (*8*) has shown that a very small amount of air can greatly reduce the transfer when operating with static steam. Further, these gases are swept by the steam to the points where steam velocities are low. Unless these pockets of noncondensable gases are removed, nonuniformity of heat transfer will result. Even in driers operating with blow-through steam, gas pockets may form if the steam inlet and outlet are so located as to short circuit the main chamber.

Detection of the presence of noncondensable gases is extremely difficult, because the usual method of checking the temperature and pressure of the entering steam is not applicable unless the noncondensable gas is uniformly distributed throughout the steam space. In the drier the temperature of the steam will still be the same as that of the entering steam, irrespective of air collecting on the cold surface or in some remote corner. Even when complete diffusion takes place, it would take a considerable quantity of noncondensable gas before its presence could be practically indicated by the temperature-pressure method, especially if the quality of the entering steam is high. The presence of superheat in the entering steam completely eliminates the temperature-pressure method. Uneven moisture content across the sheet is only a clue at best since it can also be caused by conditions external to the drier. Another complication arises in that nonuniform steam flow, as well as gas pockets, can cause uneven transfer.

THE EFFECT OF STEAM VELOCITY ON HEAT TRANSFER

Except in the case where the condensate is rimming, the effect of the water film on heat transfer has been considered in the preceding paragraphs only for low steam velocities. Steam velocity not only causes movement of noncondensable gases, but also has a definite shearing effect on the condensate film. A properly oriented vapor velocity can reduce the thickness of and/or promote turbulence in the condensate film. The degree of improvement depends chiefly on the nature of the film and must be determined experimentally.

A METHOD FOR DETERMINING THE APPROXIMATE INSIDE COEFFICIENT FOR A PAPER DRIER

Much can be accomplished through research along the lines indicated. Since each problem in the field involves many factors which would be difficult to duplicate in the laboratory, and would vary for different installations, the only practical approach is through field studies. Each paper mill can benefit greatly by making a relatively simple experiment to determine the approximate internal resistance in driers for its particular operation.

Such experimentation would involve the following:

1. Locate the region where free moisture in the paper is evaporating at an approximately constant rate, by recording the temperature of the sheet through the machine. In this region, the temperature of the sheet will remain fairly constant.
2. Measure sheet moisture content entering and leaving a bank of approximately 16 driers in this region.
3. Measure the surface temperature of each drier with a conventional shoe-type pyrometer which has recently been calibrated. Only fair accuracy is necessary.
4. Measure steam temperature and steam pressure accurately with calibrated instruments. The 16 driers should be operating at the same steam temperature.
5. Measure untrimmed sheet width, and record speed and basis weight for the run.

With these data, the mean over-all coefficient between the steam and the outside drier surface can be calculated. The equation for the coefficient is as follows:

$$U_{so} = \frac{Q}{A(t_s - t_o)} = \frac{W\lambda}{A(t_s - t_o)}$$

where

W is the total pounds of water evaporated per hour in the bank of 16 driers
λ is the latent heat of vaporization at the mean sheet temperature
t_s is the steam temperature
t_o is the mean drier surface temperature

A is taken as the total surface area of the driers since heat is assumed to be transferred uniformly from the steam to the entire surface. This is generally true because the heat stored in the thick shell is usually large compared with the heat removed per revolution (*9*), and the shell temperature remains nearly uniform. Compensation, in part, for the radiation from the shell surface is made by including all the latent heat of the water evaporated between driers, and because the surface temperature at the point of measurement will be slightly higher than the mean surface temperature. By accounting for the resistance of the shell, the mean inside coefficient can be obtained from U_{so}.

A few field experiments of this type have yielded approximate mean inside coefficients ranging between 65 and 450 B.t.u. per (hr.) (sq. ft.) (°F.).

CONCLUSION

In summary, we can make the following conclusions:

1. Conditions in a rotating drier are so divergent

from those found in a common shell and tube heat exchanger that extreme care must be taken in making analogies from one to the other. While basic theory may apply equally in both cases, experimental data can be misleading when shell rotation is a factor.

2. At nonrimming speeds, the condensate film coefficient is not a constant high value. In general, it is of low order and varies with load and speed. Its magnitude for a particular operation is best determined by field tests. Properly directed vapor velocity may improve existing coefficients. The geometry of the steam path and the steam flow rate, however, must be considered in every case.

3. At rimming speeds, the resistance of a layer of water is appreciable. Improvements of coefficients through vapor velocity must be determined experimentally. Speed and mechanism for removing condensate will be important factors in every case.

4. As a goal for improving the design of cylindrical driers, development engineers should consider designing driers that incorporate the following characteristics: (a) unquestionable uniformity of transfer under all conditions of load and vapor velocities, and (b) a condensate removal arrangement inside the drier that will yield high steam-side coefficient at all speeds, while utilizing the same condensate removal mechanism.

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Received Oct. 7, 1952. Presented at the Seventh Engineering Conference of the Technical Association of the Pulp and Paper Industry, Chicago, Ill., Oct. 13–16, 1952.

The author wishes to express his appreciation to Robert E. White, chairman of the Chemical Engineering Department at Villanova College for his generous assistance in preparation of this paper.

Errata—Studies on Modified Cellulose, I

by Alexander Meller

In the paper "Studies on Modified Cellulose I" published in the April, 1950, issue of *Tappi* on pp. 171–179, the following corrections should be made: 172, col. 1, para. 2, line 7, read "increased" instead of "reduced"; 172, col. 1, para. 2, line 13, read "hypoiodite" instead of "hypoiodate"; 172, col. 2, para. 2, line 4, read "hypoiodite" instead of "hypoiodate"; 175, Table II, lines 3, 6, 10, 13, 16, 20, and 29, insert the word "Blank"; 175, Table II, line 17, read "Chlorite (1) dichromate oxycellulose II" instead of "Chlorite (1) dichromate oxycellulose III"; 175, col. 2, line 4, read "reduced" instead of "increased"; 177, col. 1, line 9, read "0.000065 and 0.000095" instead of "0.00065 and 0.00095"; 178, col. 1, para. 3, lines 6, 7, 8, read "would form less readily by enolization alkali sensitive structural units" instead of "would be deprived of the ability of forming by enolization alkali sensitive structural units"; 178, col. 2, para. 1, line 9, read "increased" instead of "decreased."

In the paper "Studies on Modified Cellulose II" published in the February, 1952, issue of *Tappi*, pp. 72–75, the following errors were noted: 73, Table I, lines 2 and 11 read "0.05 N HIO_4" instead of "0.5 N HIO_4"; 73, Table IIA, line 9, read "Gluconic acid oxycellulose IV" instead of "Oxycellulose IV gluconic acid."

In the paper "Studies on Modified Cellulose III" published in the June, 1953, issue of *Tappi*, pp. 264–267, some omissions and errors should be rectified: 264, subheading, read "III Characterization of the Reactivity and Supermolecular Structure of Cellulose Fibers" instead of "III Characterization of the Reactivity and Supermolecular Structure Cellulose Fibers"; 265, col. 1, the second equation should read "$a = a_1 + a_2$" instead of "$a = a_2 + a_2$"; 265, col. 2, line 1, insert "t" after "and"; 265, equation (3), read "$dx/dt = k_1 - k_2a_1 + k_2a - k_2x + k_1k_2t$" instead of "$dx/dt = k_1 + k_2a_1 + k_2a - k_2x + k_1k_2t$"; 265, equation (M), read "Increment dx/dt = Increment $x \cdot k_2 - k_1k_2\ \tau$" instead of "Increment $dx/dt = \tau k_2$ increment $x = k_1k_2\ \tau$"; 266, second table, footnote, line 1, read "$^a\ xS.P = 0.254 + 7.33 - 6.7\ e^{-0.3t}$," "$^b\ xT.C. = 0.52t + 16.7 - 11.7e^{-0.3t}$" instead of "$^a\ xS.P. = 0.25t + 7.43 - 6.7e^{-t0.30}$," "$^b\ xT.C. = 0.52t + 16.7 - 11.7e^{-t0.03}$"; 266, col. 2, line 1, read "the temperature coefficient" instead of "the temperature of coefficient"; 267, col. 2, final equation, read "Increment (dx/dt) = Increment $x \cdot k_2 - k_1k_2$ time interval" instead of "Increment $(dx/dt) = k_2$ increment $x = k_1k_2$ time interval,".

ASSOCIATION NEWS AND EVENTS

Fall Conferences

The Paper-Plastics, Testing, and Fibrous Agricultural Residues Conferences have been completed. Two conferences remain to be held:

Eighth Engineering Conference, Sheraton-Mt. Royal Hotel, Montreal, P. Q., Oct. 26–29, 1953.

There has been a change in the program of the conference as published in the August issue of *Tappi*, page 72A. In the Materials Handling Session the paper "Use of Gasoline vs. Electric Trucks in the Paper Industry," by R. F. Weber, International Harvester Co., Chicago, Ill., has been withdrawn. In its place will appear a paper, "A Pulpwood Flume System," by John R. Fielding, Union Bag & Paper Corp., Savannah, Ga.

The Collector of Canadian Customs advises that bona fide manuscripts which consist of typewritten or handwritten sheets and which are going to be used during the conference will be entitled to duty-free value as of no commercial value. Printed matter or other descriptive pamphlets which would serve as advertising matter are subject to the payment of duty at the rate of 25% under tariff item 178 with the collection of 10% federal sales tax calculated on the duty paid value of the printed matter imported.

Seventh Alkaline Pulping Conference, Rice Hotel, Houston, Tex., Nov. 19–20, 1953. (See the September issue of *Tappi* for program.)

Annual Meeting 1954

Thirty-Ninth Annual Meeting, Commodore Hotel, New York, N. Y., Feb. 15–18, 1954. Individuals or companies desiring to present papers should advise the Secretary of the Technical Association right away. Manuscripts in quadruplicate are due on Dec. 1, 1953.

The following preliminary programs indicate the sessions that have been reserved to date:

General Session

1. "Fiberglas as a Papermaking Material," by Thomas S. Chambers, Owens-Corning Fiberglas Co., Newark, Ohio.
2. "The Pulp and Paper Industry in the Far East," by Roland A. Packard, Mutual Security Agency, Washington, D. C.

Chemical Engineering

1. Digester Corrosion Symposium.

Chemical Engineering

1—Three-hour session.

Pulps for Chemical Conversion

1. Paper by A. T. Maasberg and Richard Swinehart, Dow Chemical Co., Midland, Mich.
2. Paper by Merle Heath, Buckeye Cotton Oil Co., Memphis, Tenn.
3. Paper by R. C. Blume, du Pont.
4. F.P.L. paper on "Purified Hydrolysis Sulphate Pulps from Sweetgum."

Statistics

2—Three-hour sessions.

Water

1—Three-hour session.

Alkaline Pulping

1—Three-hour session.

Semichemical Pulping

1—Three-hour session (2 papers committed).

Papermaking (Fourdrinier)

1. "Use of Tracerlab Mass Per Unit Area Instrument on Newsprint, Felt Wear, and Wire Wear."
2. Paper on Secondary Headboxes.

Papermaking (Fourdrinier)

1—Three-hour question-and-answer session for committeemen and representatives of mills operating fourdrinier machines.

Structural Fibrous Matcrials

1. "Evaluation of the TAPPI-SFMC Drainage Time Tester for Mill Control of Insulating Board Pulps," by David Haig, Johns-Manville Research Center, Manville, N. J.
2. "Evaluation of the TAPPI-SFMC Drainage Time Tester from TAPPI T 1002 sm-51," by Jules Perot, Flintkote Co., Whippany, N. J., and C. E. Hrubesky, Forest Products Lab., Madison, Wis.
3. Panel Discussion—"Drainage Time Testing of Insulating Board Stocks; The Features and Shortcomings of the Test." Panel Members: T. C. Duval, Wood Conversion Co., C. E. Hrubesky, Jules Perot, and David Haig.

Microbiological

1—Three-hour session.

Corrugated Containers

4—Three-hour sessions.

Pulp Purification

1. "New Process for the Bleaching of Chemical Pulps, Especially Kraft with Either Sodium Peroxide or Hydrogen Peroxide," by W. F. Schroeder, National Distillers Co., Ashtabula, Ohio.

Papermaking (Cylinder)

4—Three-hour sessions.

1. "Raw Materials—Pulp Characteristics as Related to Paperboard Products," by A. E. Bachmann, Missisquoi Corp., Sheldon Springs, Vt.
2. "Odor Problems of Paperboard," by H. G. Booth, Robert Gair Co., Uncasville, Conn.
3. "Stock Preparation (Effect on Wet-End Operation)," by E. F. Manogue, Gibraltar Corrugated Paper Co., North Bergen, N. J.
4. "Wet-End Operation of Cylinder Machines," by George C. Ehemann, Ohio Boxboard Co., Rittman, Ohio, and W. R. Czellak, Gardner Board & Carton Co., Middletown, Ohio.
5. "End-Use Requirements and Testing," by A. T. Luey, Sutherland Paper Co., Kalamazoo, Mich.

1954 Coating Conference

The Fifth Coating Conference of the Technical Association will be held at the Poland Spring House, Poland Spring, Me., from May 23 to 26, 1954.

Previous conferences have been held at Grand Rapids, Mich., Boston, Mass., Chicago, Ill., and Cincinnati, Ohio.

Local Section Meetings

Pacific: Longview, Wash., Nov. 3, 1953.

Lake States: Conway Hotel, Appleton, Wis., Nov. 10, 1953.

Delaware Valley: Engineers Club, Philadelphia, Pa., Oct. 22, 1953; Riegel Paper Corp. Clubhouse, Riegel Ridge, N. J., Dec. 4, 1953.

Kalamazoo Valley: Harris Hotel, Kalamazoo, Mich., Nov. 5, 1953, "A New Method of Paper Drying," Dec. 3, 1953, "Significance of Paper Tests."

New England: Roger Smith Hotel, Holyoke, Mass., Dec. 4, 1953.

Ohio: American Legion Hall, Middletown, Ohio, Nov. 10, 1953. "Problems of Closing a White Water System"; Dec. 8, 1953. "Radio Isotopes in the Paper Industry," by C. A. Sankey, Ontario Paper Co., Thorold, Ont.

Empire State (Metropolitan): Fraunces Tavern, New York, N. Y., Oct. 20, 1953, and Nov. 10, 1953.

Empire State (Northern): La Martinas Restaurant, Watertown, N. Y., Nov. 12, 1953. Paper by Henry J. Perry, Waste Paper Utilization Council. New York, N. Y.; Dec. 10, 1953, "Slime Control."

Empire State (Eastern): Glens Falls, N. Y., Nov. 19, 1953, Training Program.

Maine-New Hampshire: Lafayette Hotel, Portland, Me., Oct. 23–24, 1953.

Southeastern: Fort Sumter Hotel, Charleston, S. C., Dec. 4, 1953. Technical program and tour of the mill of the West Virginia Pulp & Paper Co.

CPPA Technical Section: Sheraton-Mt. Royal Hotel, Montreal, P. Q., Jan. 28–30, 1954.

Maine-New Hampshire

The Fall meeting of the Maine-New Hampshire Section will be held at the Lafayette Hotel, Portland, Me., on Oct. 23–24, 1953. Following registration on October 23 from 11:00 a.m. to 2:00 p.m. the technical program follows:

1. "Glue as an Additive on the Paper Machine," by Richard Tutt, Peter Cooper Co., Gowanda, N. Y.
2. "The Use of Keratene on the Paper Machine," by M. H. Deems, the Keratene Co., Winsted, Conn.
3. "Foam Problems," by representative of the National Aluminate Co., Chicago, Ill.
4. "Natural Gum Products as Aids in Improving Paper Qualities," by M. L. Cushing, Stein, Hall & Cos., New York, N. Y.
5. "New Size Press Starch," by Leonard Wood, National Starch Products Co., New York, N. Y.
6. "Effect of Hi-Sil and Silene E.F. on the Optical and Physical Properties of Paper," by L. B. Taylor, Columbia-Southern Chemical Corp., Pittsburgh, Pa.
7. "Use of Latex at the Size Press," by Edward J. Heiser, Dow Chemical Co., Midland, Mich.

At 7:00 p.m. there will be a dinner-dance in the Mayfair Room of the Lafayette Hotel.

Saturday morning's program will be devoted to a panel discussion on "Paper Additives."

The meeting will end at 11:30 a.m. to enable those individuals interested in attending the college football games to arrive at their destinations on time. Maine and Bates will play at Lewiston, Me., and Bowdoin and Colby will play at Brunswick, Me. The games start at 1:30 p.m.

The Technical Program Committee consists of A. E. Jones, Oxford Paper Co., Rumford, Me., and F. N. Sprague, St. Regis Paper Co., Bucksport, Me.

The Local Arrangements Committee consists of J. F. Wright, National Aniline Div., Boston, Mass., chairman, J. J. Thomas, S. D. Warren Co., Cumberland Mills, Me., and chairman of the Maine-New Hampshire Section, and H. E. Pratt, Pejepscot Paper Co., Brunswick, Me.

Kalamazoo Valley

The Kalamazoo Valley Section has announced the dates of its 1953–54 meetings. All meetings will be held at the Hotel Harris, Kalamazoo, Mich.:

Oct. 1, 1953—"Utilization of Waste Paper," by Henry J. Perry, Waste Paper Utilization Council, New York, N. Y.

Nov. 5 1953—"A New Method of Paper Drying," by Joseph Gillis, Martinson Machine Co., Kalamazoo, Mich.

Dec. 3, 1953—"Significance of Paper Tests," by J. A. Van den Akker, Institute of Paper Chemistry, Appleton, Wis.

Jan. 7, 1954—Joint Meeting with Michigan Div. of the Superintendents Association.

Feb. 4, 1954—"Alkaline Sizing."

March 4, 1954—"Graphic Arts."

April 1, 1954—"Engineering."

May 6, 1954—Western Michigan College Senior Thesis Presentations.

June, 1954—Fun Day at Gull Lake.

1953 Paper-Plastics Conference

The 1953 Paper-Plastics Conference, sponsored by the Technical Association of the Pulp and Paper Industry, was held at the College of Forestry, State University of New York, Syracuse, N. Y., Sept. 15–16, 1953. Over 150 individuals were present to take part in the programs which were arranged by H. F. Mark, Polytechnic Institute of Brooklyn, J. C. Pullman, American Cyanamid Co., and Vivian T. Stannett of the College of Forestry.

R. T. Nazzaro, Westfield River Paper Co., chairman of the Plastics Committee, opened the program by introducing H. C. Belyea, acting dean of the college, who welcomed the group to Syracuse. The first session, under the chairmanship of Mr. Mark, was on new resin development. T. G. Rochow of the American Cyanamid Co. was the first speaker, his subject being "Resinography." While resinography is relatively new, being started in about 1935, its principles have long been used in the metals industry in its study of crystal construction as it relates to the properties of steel, brass, and other metals as they are processed. Mr. Rochow explained his subject with the concept "making—using—seeing" and indicated with numerous illustrations how crystal structure changes can be viewed through the use of various optical instruments and techniques. The advantage of the optical system is that the particles can be studied without destroying the structure of the plastic material under observation. Individual components can be examined for their interrelationship and the effects of manufacturing and processing variables can be ascertained.

R. B. Mesrobian, Polytechnic Institute of Brooklyn, spoke next on "Block and Graft Copolymers." These are a relatively new group of plastic materials and their development is just beginning. If the structure of a regular copolymer is represented by ABAB—the architecture of the structure can be varied to obtain different properties. The alternating type would be A BA BA BA. To obtain the block copolymer the components are arranged to form a long sequence of each group: AAAA-BBBB. The graft copolymer can be represented by:

```
A A A A A A
  B   B   B
  B   B   B
  B   B   B
```

where there is a backbone of one component to which the other, in chains of variable length, is attached. The regular

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copolymer is characterized by a melting point change in definite relationship depending on proportion, the alternate by a melting point drop, no change for the block structure, and it is speculated that the melting point drop depends on the effect of the branches in the case of the graft type. The general techniques for the preparation of block copolymers are (1) use of expansion agents; (2) co-condensation of primary blocks, and (3) second stage polymerization by (a) flow system techniques, (b) polymerization techniques, and (c) labile group techniques. The graft types are prepared by (1) styrenation of unsaturated polyesters, (2) chain transfer techniques, (3) side chain polymerization, and (4) use of polymeric hydroperoxides. Several block and graft copolymers are now in commercial usage and it is expected that there will be more in the future.

T. A. Walb of the Shell Chemical Corp. was the last speaker at the morning session. In discussing the epoxy resins, Mr. Walb mentioned that polymers, generally, constitute the fastest growing segment of the chemical industry. The epoxy resins were discovered about 1891 but it was not until 1946 that they became of commercial interest due, in general, to the previous unavailability of the raw materials and high cost. About that time the Ciba Co. became interested in this product as a base for adhesives and concurrently, Devoe & Raynolds, paint manufacturers, for surface coatings. The epoxy resins are characterized by high resistance to water, acids, and alkalis; toughness; good adhesion; low shrinkage; and good electrical resistance. The basic resin can be varied in viscosity and is reacted with other polyresins to form new polymers with varying characteristics depending on the final results desired. They are being used in industrial paints and as adhesives especially for the bonding of metals to metals. In the laminated field they have been used by the electrical industry for printed circuits. Mr. Walb indicated that much more research work will be required before the epoxy resins can be considered developed and that there is more than reasonable expectation that the usage will be extended to a wide variety of products.

An informal luncheon was held at Drumlins Country Club, after which the group reconvened at the Forestry College. H. F. Mark of the Polytechnic Institute of Brooklyn spoke on "Recent Developments of Plastics in Europe." Mr. Mark did not particularly discuss specific products but confined his remarks to the development work carried on, especially in England and Germany. There is interest in ring opening polymerization whereby rings of four, five, or more units are being opened to form a whole new series of polymers which are capable of almost unlimited variation. The graft and block copolymers, previously discussed by Mr. Mesrobian, are also under observation. From these polymers products with high abrasion resistance, inertness with hydrocarbons (less swelling), better aging resistance, and hard but not brittle coatings have been formulated.

Mr. Mark then discussed briefly a recent development which was discussed at the cellulose meeting held in Stockholm. By the use of heavy water a method was devised to indicate degree of crystallinity of cellulose. The results obtained were checked by an x-ray technique which showed very good agreement.

Next on the program was F. R. Eirich, also of the Polytechnic Institute of Brooklyn, who discussed the progress in the polyesters field. The synthesis of polyesters in a linear form is rather easily accomplished. By varying the acids used various variations in properties may be accomplished. If a ring is introduced into the chain it is possible to increase the degree of crystallinity and the melting point. The various chains may be cross linked and the further addition of groups to the side chains create varying properties. For instance, the addition of chlorine atoms gives flame resistance to the product. Styrene is a reasonably good solvent for polyesters. Catalysts are added to assist the cure by lowering the temperature and time required. However, they affect adversely the storage life but this can be controlled to some degree by the use of an inhibitor.

Another recent addition to the polymer industry, the fluorocarbons, was described by H. S. Kaufman of the M. W. Kellogg Co. in the paper "Modified Polymers Containing Fluorine." These materials were developed in connection with atom bomb research when special compounds were required as materials of construction. They are characterized by high thermal stability and chemical inertness. Teflon, which is tetrafluoroethylene, is a member of the group. The fluorocarbon has a helex structure and can be modified by the replacement of fluorine with chlorine to form other high poly-

Group attending the Paper-Plastics Conference held at College of Forestry, Syracuse, N. Y., Sept. 15–16, 1953

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mers that are in amorphous to crystalline forms. The resin can be extruded or molded but solutions are not immediately available because of the necessity for high temperatures and high cost of the solvent. By using an organasol dispersion the material can be applied to a metal surface and then fused on to make a highly resistant coating. At present the use of these materials is predominantly for corrosive resistant coatings, pipings, and insulation applications but it is expected that other uses will be developed in the future.

Wednesday's session was devoted to developments in the application of resins to papers and J. C. Pullman of the American Cyanamid Co. acted as chairman. The first paper, "Plasticizers—Their Use in Paper Coating Resins," by H. S. Bergen and J. R. Darby, Monsanto Chemical Co., was presented by Mr. Bergen. There are some resins which require no plasticizer but most of them do to improve such properties as scuff, gloss, heat sealability, and water and water vapor resistance. In the consideration of the proper plasticizer there are three factors which must be taken into consideration: (1) selection of the resin, (2) method of application, and (3) the cost. The selection of the resin depends on the performance expected of the end product. Food products require components that are nontoxic, odorless, and tasteless. Grease resistance may be necessary. Shelf papers, covers, and leather board need flexibility with less volatility and migration. The melting point is important in a label paper, flame resistance in building boards, and insulation value in electrical papers. The plasticizer must then be chosen on the basis of its compatibility with the resin and its processing characteristics which can be divided into performance and permanence variables. Performance requires the consideration of such requirements as flexibility, softness, strength, flammability, abrasion resistance, heat sensitivity, electrical properties, toxicity, color, and odor needed for the end product. Likewise the end product must dictate the permanence characteristics such as volatility and migration. Mr. Bergen in discussing the above factors and variables illustrated his points with numerous recommendations as the effect and use of many of the commonly used plasticizers.

"The Use of Inorganic Synthetic Fiber Paper for Laminates" by H. F. Arledter of the Hurlbut Paper Co. was the next paper. His discussion was confined to glass fiber papers and Mr. Arledter emphasized that at the present time they must be considered as a specialty item tailor-made for each type of application. A more universal product and more favorable costs will have an effect on future usage. There are several types of glass fibers available for papermaking and, in general, have such properties as slight solubility, not affected by heat, excellent electrical resistance, and slight water absorbency. The paper also prints well which is attributed to the fineness of the fibers. Mr. Arledter stated that they have investigated over 80 binder systems to date and none were perfectly satisfactory. Consequently, the end use must be specified. The main problem in laminating is the high resin pickup which may increase curing time. It can be improved by pressing but this is limited as heavy contact will destroy the fibers. Much work is still to be done but already glass-filled papers have found considerable use in the electrical industry where high electrical resistance and dimensional stability are so important.

Because of time limitations, G. L. Booth of the Dilts Machine Works gave the last paper in the morning session. The title was changed from that given in the program to "Reverse Roll Coating of Hot Melt Coatings." Mr. Booth first described the four-roll reverse roll coater in their laboratory which is 18 in. wide and can be operated at temperatures up to 350°F. The roll speed ratios may be varied to more accurately control coating weights and throughout his paper Mr. Booth cited the changes that were made during the course of their experiments. Trials were made with polyethylene wax blends, polyamides, paraffin wax, modified synthetic carnauba wax, and asphalt. Difficulty was experienced when the viscosity of the solution was over 15,000 cp. Also, high gloss was not attained but this was due to improper chilling which can be corrected. No difficulty was experienced with the polyamides but, although the control was good with paraffin, no particular advantage was apparent over conventional procedures. The same was true in the case of the modified carnauba and asphalt. A gravure roll worked well for heat seal applications giving practically no variations in coating weight. Mr. Booth stressed that their work was introductory and that, because of the versatility of their equipment, they would try all suggestions to determine its applicability to a problem.

Luncheon was again at Drumlins, among the guests being the Austrian group that is now in the United States under the auspices of the Foreign Operations Administration.

"Polyethylene Extrusion Lamination Techniques" by H. A. Arbit, Bakelite Co., was the first paper after lunch. Polyethylene was introduced in England in 1933 and in 1943 it was first made in the United States by Union Carbide. By 1952 production had reached 125 million pounds and it is expected that by 1955 the figure will reach 500 million pounds. About one third is used in packaging where water and water vapor resistance, grease resistance, heat sealability, and low temperature flexibility are important factors. Polyethylene is made in various molecular weights from 12,000 to 23,000, the lower being characterized by easier flow, the higher by greater strength. Application to foil requires that the sheet be degreased if maximum adhesion is to be attained. The extruding temperature is very important in adhesion, going up to 640°F. depending on the type used. This is higher than that used for the unsupported film. However, if too high, the physical characteristics will degrade, there will be excessive gloss, tackiness, and odor development. On the other hand, if the temperature is too low, there will be poor hot stretch, poor clarity, and a rough surface. The extruder should be located as close to the rolls as possible to prevent heat loss. Quenching is important also. Recently, the polyethylene films have been improved by postheating in which the sheet is heated on the coated side after application to the sheet. This procedure, however, has not had a beneficial effect on films applied to cellophane.

The last formal paper was presented by F. Hayes of The Noble & Wood Machine Co. In 1947 Alvin Simpson of Plainfield, N. J., conceived the idea of a forming machine for the manufacture of heavy sheets using compressed air. His preliminary work indicating the soundness of the idea, a unit 48 in. diameter with a 6-in. face was constructed. This provided a satisfactory continuous sheet and a larger model was then made by Noble & Wood with a cylinder 60 in. diameter and a 36-in. face. Briefly, the equipment consists of a wire-covered open cylinder which revolves in an air-tight casing that covers about three fourths of the circumference. Rolls are provided to seal the chamber and permit the exit of the formed sheet. In operation, stock is pumped into the lower section and compressed air in the top sufficient to balance the stock pressure which is held at about 80 p.s.i. The pressure forces the water through the wire on the cylinder forming the sheet which then forms a seal as the rotation raises the sheet above the stock level. A smoothing roll is provided to press the sheet and also increase the effectiveness of the sheet as a seal in the compressed air zone. A continuous sheet, uniform in thickness and density, is produced 50 to 80% moisture-free at speeds from 35 to 350 f.p.m. While first used with asbestos and cement, boards from all types of fibers have been made. Resins can be added to the stock to produce a plastic-filled sheet which then can be laminated. It also has an application in pulp washing.

At the end of the formal program, a panel discussion was held on "The Beater Addition of Resins." J. C. Pullman acted as chairman and was assisted by John Baymiller, Armstrong Cork Co.; Fred R. Ramage, Latex Fiber Industries, Inc.; Horace Spencer, Knowlton Bros., Inc.; Robert H. Walsh, E. I. du Pont de Nemours & Co.; Chester G. Landes, Ameri-

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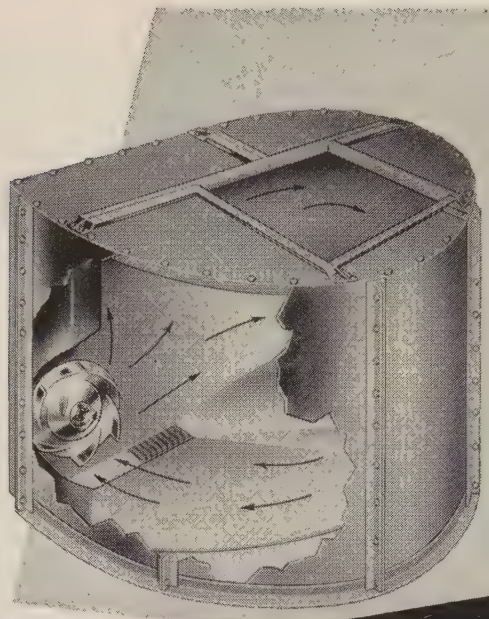

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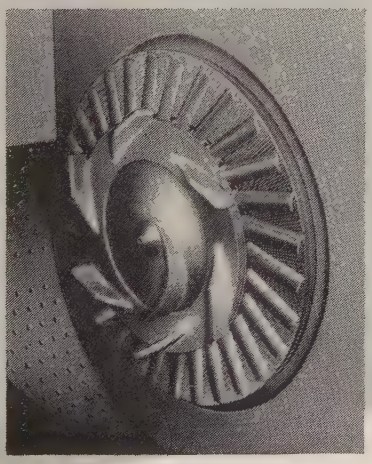

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can Cyanamid Co.; and T. A. Howell, Institute of Paper Chemistry.

Mr. Baymiller suggested that since there is a fundamental mechanism for resin adhesion it might be explained on the basis of the differences and variations of the electrokinetic or zeta potential of the fiber, the resin, and other components of the system.

Mr. Ramage indicated the importance of the addition variables both as to time and place of addition and the temperature and pH of the suspension.

Mr. Walsh confined his remarks to the properties which are developed by the synthetic latices GRS, GRN, and Neoprene.

Mr. Howell warned of the possible difficulties involved in the measurement of retention and the dangers of too high a solubility loss, especially in the use of phenolics.

Mr. Spencer indicated the basic differences between fibers treated by beater addition and by saturation. He emphasized that they both had markets but in different fields so that the two methods were not necessarily competitive.

Finally, Mr. Landes described the Bardac process in which the melamine resin is just added to a pulp suspension, followed by a thermoplastic resin emulsion. The result is high retention of the thermoplastic resin.

After these remarks, the meeting was opened for general discussion.

During the session it was decided in a meeting of the Plastics Committee to hold a conference at the Polytechnic Institute of Brooklyn in the Fall of 1954. In 1955 it is expected that the Plastics Conference will be held at The Institute of Paper Chemistry, Appleton, Wis.

Appreciation was expressed to the staff of the College of Forestry for its cooperation and the use of its facilities for the 1953 Paper-Plastics Conference.

Research Appropriations

In 1935 the Technical Association initiated a program of financing research projects related to the activities of its divisions and committees. It was felt, at the time, that many technical problems recognized by the committees would remain unsolved unless they were clearly defined and investigated by competent personnel.

The Association in 1935 was relatively small and had limited funds available to finance the early research projects. From 1935 through 1952 the amount of the appropriations for committee projects totaled $69,682.60, of which nearly 75% was granted during the last two years.

Recently a request came from Sweden for a list of the committee projects financed by research grants from the Association. The following compilation has been prepared by John L. Parsons, chairman of the TAPPI Research Appropriations Committee, in response to this request. It is published here as a subject of general interest.

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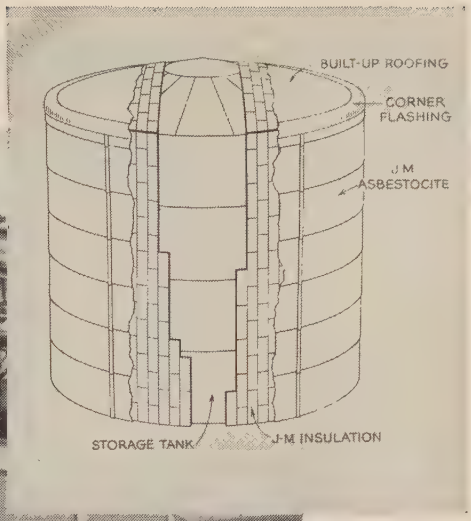
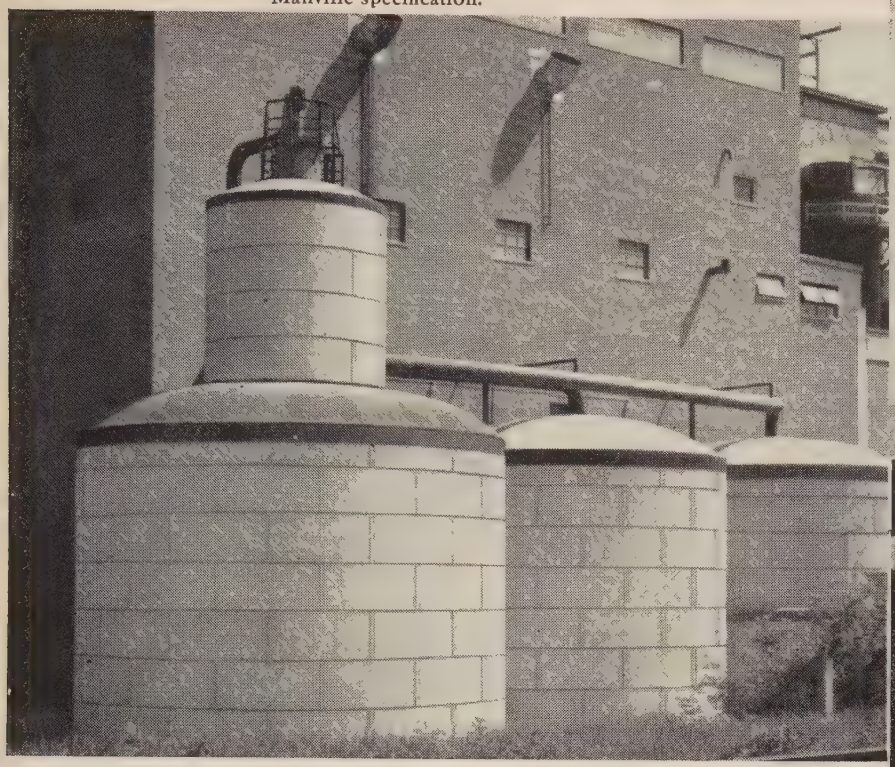
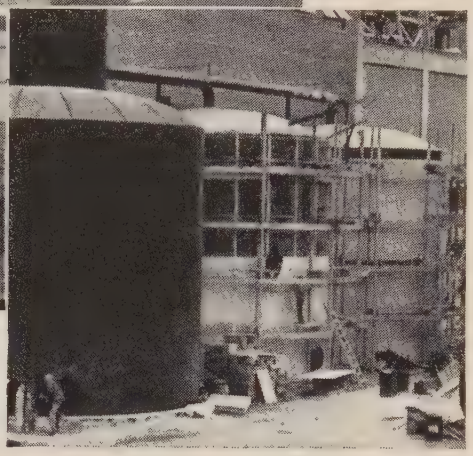
Cutaway drawing shows how J-M *Weather-Protected* Insulation is applied to tanks such as those at the S. D. Warren Company paper mill. Standard methods for mechanical securement of the insulation are used. Asbestocite sheets are then applied over the insulation, in accordance with the simplified Johns-Manville specification.







▲ **(Above)** Completed job of J-M *Weather-Protected* Insulation on black liquor tanks of the S. D. Warren Company.

(Right) Skilled applicators of an outstanding J-M Insulation Contractor, P. S. Thorsen Co. of South Boston, Mass., applying Asbestocite sheets over Zerolite insulation.

S. D. Warren Company saves fuel, reduces maintenance on outdoor tanks with J-M *Weather-Protected* Insulation

On black liquor tanks of the S. D. Warren Company paper mill at Cumberland Mills, Maine, Johns-Manville *Weather-Protected* Insulation pays a "double dividend":

It saves money on fuel and maintenance. J-M Zerolite* insulation keeps the heat in . . . thereby saving a substantial amount in fuel costs. J-M Asbestocite*, a strong asbestos-cement sheet material, covers the Zerolite Insulation to protect it both from the weather and from wetting due to normal plant operations. This "bodyguard" layer of Asbestocite Weather Protection makes the tanks virtually maintenance-free and helps hold down operating costs.

It helps provide close temperature control. The temperature of black liquor in these tanks must be maintained so that it will flow freely and not clog up pumping apparatus. J-M Weather-Protected Insulation helps do the job dependably and economically.

Whatever the operating temperature of outdoor tanks and vessels, Johns-Manville offers the right insulation for application under the Asbestocite weather protection. For example, J-M 85% Magnesia Insulation is also widely used for this service because of its proved performance for temperatures to 600 F.

To be sure that the insulation and its weather protection is properly applied to pay the greatest return on your investment, J-M offers the services of experienced J-M Insulation Engineers and J-M Insulation Contractors. These men stand ready to give you an insulation job that will more than pay off your initial investment through maximum fuel savings.

For further information about J-M Weather-Protected Insulation, write to Johns-Manville, Box 60, New York 16, New York. In Canada, 199 Bay Street, Toronto 1, Ontario. *Reg. U.S. Pat. Off.

Johns-Manville FIRST IN INSULATION

MATERIALS • ENGINEERING • APPLICATION

Research project No.	Appropriation, dollars	Year	Project	Committee	Literature reference
1	150	1935	Study of mechanical pulp refiners by fiber classification	Mechanical Pulping	1
2	1000	1935	A study of the existence and nature of fiber membranes	Fundamental Research	2
9	1000	1937R[a]		Container	
3	...	...	(Cancelled by sponsoring committee)	Fibrous Materials Testing	3
4	600	1936	An investigation of holocellulose	Fibrous Materials Testing	
8	600	1937R	.....	Fundamental Research	
10	600	1938R	.....	Fundamental Research	
12	1000	1939R	.....	Fundamental Research	
17	1200	1940R	.....	Microscopical	4
5	220	1936	Bibliography: Microscopy of Paper	Fundamental Research	5
6	600	1936	Measurement of the gelatinization of cellulose and wood	Nonfibrous Materials	6
7	75	1937	Stability of calcium hypochlorite bleach liquor	Fundamental Research	7
11	1000	1938	An investigation of the relation of lignin content to the strength of paper and pressed boards		
14	1000	1939R			
18	1000	1940R			
13	540	1939	Survey of materials of construction used in kraft mills, and in the bleach plant, and an investigation of piping in the pulp and paper industry	Materials of Construction	8
15	750	1939	Use of hydroxyamines for cellulose analysis	Fibrous Materials Testing	9
16	250	1939	Preparation of a negative for dirt estimation chart for methods T 213 m-39 and T 437 m-39	Pulp Testing and Paper Testing	10
19	650	1940	A study of different types of oxidized cellulose and their identification	Fundamental Research	11
20	800	1941	Investigation of pump and valve packing materials, and materials for process piping and tubing used in kraft pulp mills	Materials of Construction	12
21	1700	1946	Variation of drying rate of individual driers through the drier section	Drying and Ventilating	..
22	350	1947	Preparation of an annotated bibliography on alkaline pulping for 1946	Alkaline Pulping	13
23	...	...	(Request for grant not approved)		
24	2000	1949	Structure of lignin	Fundamental Research	..
25	500	1950	Friction of stock in pipes	Hydraulics	14
27	2500	1951R			
37	6275	1952R			
49	5000	1952R			
26	1200	1951	Cellulose viscosity methods	Chemical Methods	..
45	1800	1952R			
28	2000	1951	Thermodynamic properties of ammonium and magnesium bisulphite solutions	Acid Pulping	..
47	2000	1952R			
29	1000	1951	Construction and testing of two freeness testers of new design	Structural Fibrous Materials	..
41	512	1952R			
30	2000	1951	A study of the sugars obtained by hydrolyzing the skinlike substance obtained from the treatment of pulp fibers with cuprammonium hydroxide	Fundamental Research	15
31	3500	1951	Dye adsorption technique for determining the external specific surface of fibers	Fundamental Research	16
32	1000	1951	Determination of the effect of rate of loading in the "Flexural Resistance and Deflection of Fiberboard" test	Structural Fibrous Materials	..
33	2500	1951	Determination of a method of test for the racking strength of insulating board sheathing	Structural Fibrous Materials	..
34	...	1951	(Request for grant not approved)		
35	3946	1951	Construction and testing of a test board forming machine for structural fibrous materials	Structural Fibrous Materials	..
36	4000	1951	Analysis of data on corrosion of digesters in kraft and soda mills	Chemical Engineering	17
38	...	1952	(Request for grant not approved)		
39	...	1952	Statistical conference (referred to Executive Committee)	Statistics	..
40	1500	1952	Development of standard methods for analysis of mill waste. Suspended solids determination by Buchner vs. Gooch methods	Water	..
42	1364	1952	Purchase, alteration, and evaluation of a Baumgartner sphere for measurement of the light reflection from insulating board finishes and coatings	Structural Fibrous Materials	..
43	2500	1952	Species identification of wood and wood fibers	Fibrous Raw Materials Testing	..
44	4500	1952	Study of North American barks of interest to the pulp industry	Fundamental Research	..
46	2500	1952	Correlation between lignin content and high kraft yield pulps and the chlorine number test	Alkaline Pulping	..
48	500	1952	Method for determination of the chain length distribution of cellulose	Chemical Methods	..

[a] The letter "R," following the year, indicates renewal of grant.

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For clean stocks – specify VORTRAPS

← Waste Paper Systems

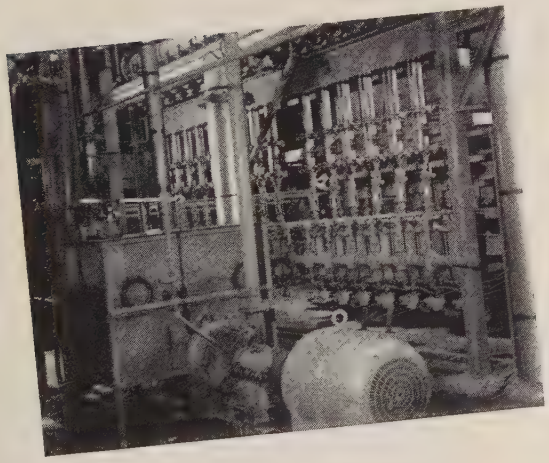
Cleaning Filler Stocks
Liner Stocks
De-inked Stocks

Robert Gair Co.
Haverhill, Mass.

Groundwood Specialty Mills →

Paper Machines
Pulp Mill

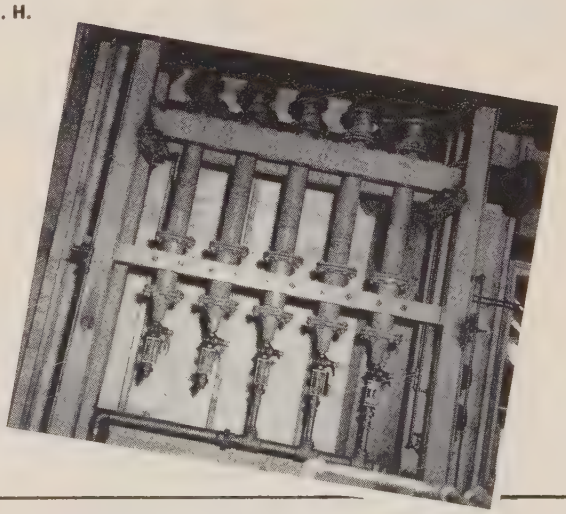
Great Northern Paper Co.
Madison, Maine



← Fine Paper Mills

Paper Machine
Pulp Mill

Brown Co.
Berlin, N. H.



Special Applications →

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Columbia River Paper Mills
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PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Russell L. Adams, Jr., Chemical Engineer, Riegel Carolina Corp., Acme, N. C., a 1950 graduate of the Virginia Polytechnic Institute.

Robert H. Bacon, President, R. H. Bacon & Co., Chicago, Ill., a 1916 graduate of the University of Illinois.

Harold O. Balough, Plant Engineer, Mill Div., Hinde & Dauch Paper Co., Sandusky, Ohio, a 1943 graduate of the University of Maryland.

George H. Burt, Chief Engineer, The Celotex Corp., Chicago, Ill., a 1921 graduate of Massachusetts Institute of Technology.

William C. Coker, Plant Engineer, Camp Mfg. Co., Inc., Franklin, Va., a 1923 graduate of the University of South Carolina, and a 1926 graduate of Massachusetts Institute of Technology.

Kenneth S. Crawford, Sales Engineer, Union Screen Co. of Canada Ltd., Lennoxville, P. Q., Canada, a 1931 graduate of University of Bishop's College, and a 1936 graduate of McGill University.

Edward J. Doonan, Sales, St. Regis Sales Corp., New York, N. Y., a 1932 graduate of Yale University.

Francis K. Duffy, Executive Assistant, Research Center, Greif Bros. Cooperage Corp., Lindenhurst, N. Y., a 1912 graduate of the University of Rochester, and a 1921 graduate of West Point Academy.

Donald G. Estebo, Engineer, Wheelwright Div., Mead Corp., Leominster, Mass., a 1946 graduate of the University of Minnesota.

John H. Freymeyer, Development Chemist, Ohio Boxboard Co., Rittman, Ohio, a 1949 graduate of Otterbein College.

Keith D. Gehr, Chemist, Hercules Powder Co., Virginia Cellulose Div., Hopewell, Va., a 1948 graduate of Carnegie Institute of Technology.

Manne H. Helgegren, Senior Draftsman, Foster Wheeler Corp., New York, N. Y., a 1947 graduate of Gothenburg Technical Institute, Chemical Div.

Attilio Hintermann, Chemist, Cartiere Ambrogio Binda SpA, Milano, Italy, a 1951 graduate of Technical Institute Bergamo.

Donald C. Kane, Technical Service Engineer, Hercules Powder Co., Paper Makers Chemical Dept., Wilmington, Del., a 1949 graduate of Princeton University.

Warren J. Kunz, Supervisor, Paper Twisting Div., Plymouth Cordage Co., North Plymouth, Mass., a 1934 graduate of Massachusetts Institute of Technology.

Axel Lundbye, Research Engineer, Kable Printing Co., Mount Morris, Ill., a 1920 graduate of Copenhagen College, Denmark.

William F. Mann, Executive Vice-President, Colloids, Inc., Newark, N. J., a 1939 graduate of the Newark College of Engineering.

William C. Mervine, Chief Chemist, Wyomissing Glazed Paper Co., Reading, Pa.

Robert B. Murphy, Librarian, Technical Library, Winchester Repeating Arms Co., Div. of Olin Industries, Inc., New Haven, Conn., a 1950 graduate of George Washington University.

Francisco J. C. Ochoa, Chemical Engineer, Cia. Industrial de Atenquique, S. A., Atenquique, Jalisco, Mexico, a 1948 graduate of University Autonoma de Guadalajara.

Roy Ott, Consultant, Donohue Brothers Ltd., Quebec, P. Q., Canada, a 1912 graduate of Oregon City College.

David W. S. Riddell, Lithographic Technician, Montreal Lithographing Co. Ltd. Attended McGill University and Sir George Williams Col ege.

Howard W. Rogers, District Manager, Canada Pumps Ltd. and Canada Blower & Forge Co., Montreal, P. Q., Canada, a 1931 graduate of McGill University.

Thomas T. C. Shih, Assistant Engineer, Research Div., Taiwan Pulp & Paper Corp., Taipei, Taiwan (Formosa), China, a 1951 graduate of Taiwan National University.

Nicholas Shisko, Assistant Chief Engineer, Abitibi Power & Paper Co. Ltd., Toronto, Ont., Canada, a 1940 graduate of Queen's University.

Alston W. Stafford, Jr., Chemical Engineer, Riegel Carolina Corp., Acme, N. C., a 1949 graduate of North Carolina State College.

Jerrol P. Strickler, Chemist, Miami Valley Coated Paper Co., Franklin, Ohio, a 1949 graduate of Miami University.

Joseph F. Voit, Divisional Sales Manager, Drackett Products Co., Cincinnati, Ohio, a 1940 graduate of Ohio University.

Richard J. Zeamer, Assistant Mill Engineer, Nekoosa-Edwards Paper Co., Port Edwards, Wis., a 1948 graduate of Massachusetts Institute of Technology.

TAPPI Notes

Robert E. Adams is now Maintenance Superintendent for the National Container Corp., Jacksonville, Fla.

O. K. Alderks, formerly Manager of the Buckeye Cotton Oil Co., is now with the Buckeye Cellulose & Specialties Corp., Memphis, Tenn.

Edward V. Alderson, Sales Engineer for the Heppenstall Co., has been transferred from Hartford, Conn., to Pittsburgh, Pa.

Ralph Atkins is now Production Manager of Potlatch Forests, Inc., Pomona Calif.,

Lee M. Bauer, Production Manager, has completed 25 years of service with the Ecusta Paper Co., Pisgah Forest, N. C.

A. B. Brackett, formerly of the General Foods Corp., is now a packaging consultant at 23 Mamaronek Rd., White Plains, N. Y.

Mamerto Cruz, Jr., formerly of the New York State College of Forestry, is now Researeh Chemist for the American Viscose Co., Marcus Hook, Pa.

Howard A. Espenmiller is now Director of Laboratories for the Black-Clawson Co., Fulton, N. Y.

Rodger L. Fife, formerly with the Krafco Container Corp., is now with the Southwest Corrugated Box Co., Sand Springs, Okla.

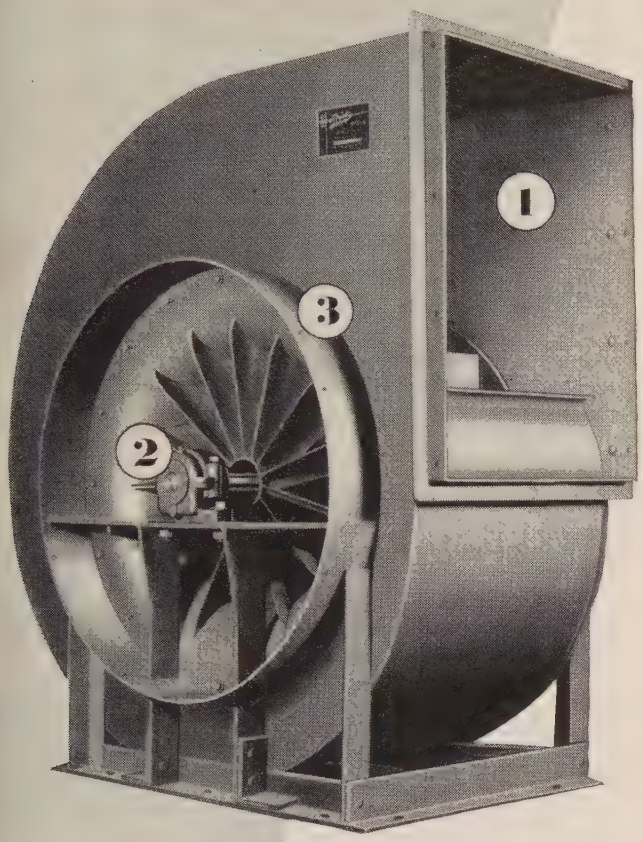
John F. Gorham, formerly of the American Cyanamid Co., is now on the staff of the Chemical Engineering Dept., University of Maine, Orono, Me.

P. Dean Graham, Jr., of the Technical Service Dept., E. I. du Pont de Nemours & Co., has been transferred from Newport, Del., to Kalamazoo, Mich.

Karl M. Guest, Plant Manager of the National Container

COMPLETE FAN

1. Streamlined housing with outlet designed for most efficient air delivery.
2. Anti-friction or sleeve bearings to suit job requirements.
3. Ample inlet collar for easy connection to ductwork.



NEW!

"Buffalo" TYPE "BL" Limit-Load Ventilating Fan

REG. U.S. PAT. OFF.

In our seventy-six years of fan manufacturing, no fan has been more respected for fine performance than the "Buffalo" Type "LL" Ventilating Fan. This fine performance is now further improved in the new "Buffalo" Type "BL" Limit-Load Fan — designed especially for general ventilation, air conditioning and industrial service.

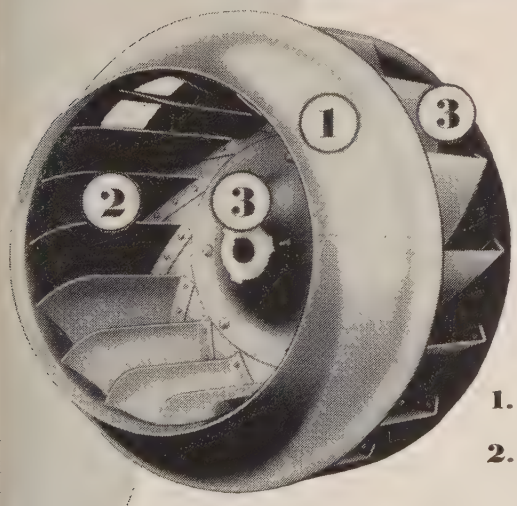
This new fan offers: (1) High efficiency; (2) Minimum noise level, over wide capacity range; (3) Full Limit-Load horsepower characteristic; (4) Stable performance from shut-off to free delivery.

Retaining the husky construction which has characterized "Buffalo" fans for many years, the new Type "BL" has some outstanding quality design features.

The Type "BL" fan will be built in standard sizes and arrangements with rotor diameters from 12¼" to 108¾", to handle from 1,000 to 500,000 cfm.

You will want this superbly-performing new fan with the "Q" Factor* on your next job! Write for new Bulletin F-100, which contains complete engineering details, including performance tables and dimensions.

** The "Q" Factor — The built-in Quality which provides trouble-free satisfaction and long life.*



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Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

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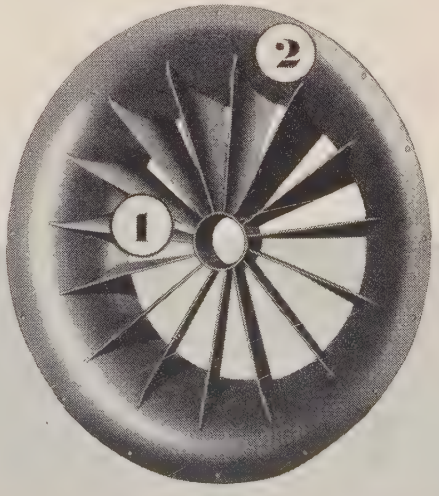
WHEEL

1. Heavy gauge die-formed shroud full curvature for proper air flow in wheel.
2. Die-formed blades curved and backwardly inclined for stable air flow. Welded and riveted for maximum strength.
3. Solid back plate with extra heavy hub.



CERTIFIED RATINGS

AUTHORIZED BY N A F M

INLET

1. Furnished as standard, and exclusive with "Buffalo", these stationary inlet vanes reduce turbulence and assure rated air delivery in spite of unfavorable inlet conditions.
2. Die-formed inlet bell matches wheel shroud.

Corp., has been transferred from Jacksonville, Fla., to Valdosta, Ga.

Harry F. Highfield, formerly Superintendent of the Liberty Paperboard Co., is now Chemical Engineer in the Board Mill Div., A & P Corrugated Box Corp., Lawrence, Mass.

Alfred Hoffman is now Technical Director of the Container Laboratories Inc., New York, N. Y.

Raymond E. Kilty is now Assistant Manager of A. E. Staley Mfg. Co., Boston, Mass.

John R. Kimberly is now President of the Kimberly-Clark Corp., Neenah, Wis.

William A. Kraske, formerly of the Solvay Process Co., is now in the Cellulose Development Dept., Celanese Corp. of America, New York, N. Y.

H. A. Lips, Manager of the Lakes, Paper and Leather Section of E. I. du Pont de Nemours & Co., Inc., has been transferred from Wilmington, Del., to Chicago, Ill.

Paul J. McLaughlin, formerly of the Hercules Powder Co., is now Research Chemist for Rohm & Haas Co., Philadelphia, Pa.

Joseph E. Mailhos, Plant Engineer for the National Container Corp., has been transferred from Jacksonville, Fla., to Valdosta, Ga.

Richard W. Moley, formerly of the Great Northern Paper Co., is now Project Engineer for the Central Paper Co. Div., S. D. Warren Co., Muskegon, Mich.

John R. Mazeau, Field Service Engineer for the National Starch Products Co., has moved from Springfield, Mass., to Route 1, Portsmouth, N. H.

James C. Morris is now Vice-President and General Manager of the Rittman Products Div., Ohio Boxboard Co., Rittman, Ohio.

Donald H. Newcomb, of the Riegel Paper Corp., has been transferred from New York City to Warren Glen, N. J., where he is Assistant Superintendent of the Hughesville Mill.

George B. Nicholson, formerly of the Black-Clawson Co., is now with the National Folding Box Co., New Haven, Conn.

Cola B. Parker is now Chairman of the Board, Kimberly-Clark Corp., Neenah, Wis.

Edward G. Paxton, Jr., formerly of the Dilts Machine Co., is now in the research laboratory of Robert Gair Co., Uncasville, Conn.

Arthur C. Proffitt, formerly student of the University of Cincinnati, is now student at The Institute of Paper Chemistry, Appleton, Wis.

George B. Redmond of Clinton Foods, Inc., has been transferred from Clinton, Iowa, to San Francisco, Calif.

Leon E. Savage, formerly of the Small Defense Plants Administration, is now with Dave Steel Co., Asheville, N. C.

George C. Schmid, formerly of the Holyoke Card & Paper Co., is now Treasurer of Trophy Papers, Inc., Holyoke, Mass.

R. Lawrence Scoville, formerly of Hollingsworth & Whitney Co., is now Research Chemist for the Robert Gair Co., Uncasville, Conn.

Robert A. Sloman, formerly of Pusey & Jones Corp., is now Chief Engineer for Doeskin Products, Inc., Rockland, Del.

W. H. Swanson is now Vice-President in Charge of Research and Development for Kimberly-Clark Corp., Neenah, Wis.

Paul Torre, formerly of De Zurik Shower Co., is now Sales Engineer for Leland Chemical Co., Milwaukee, Wis.

H. Dale Turner, formerly of the Forest Products Lab., is now Chemical Engineer for Olin Industries, Inc., East Alton, Ill.

R. W. Kenneth Ulm is now Assistant Resident Manager of Fiberboard Products, Inc., Antioch, Calif.

Albert W. Wilson, Editor of *Pulp and Paper,* has been transferred from Seattle, Wash., to Chicago, Ill.

Harland H. Young is now Assistant Director of Research for Swift & Co., Chicago, Ill.

Charles J. Zusi is now President of Container Laboratories, Inc., Chicago, Ill.

Industry Notes

Production

Paper and paperboard production during June amounted to 2,261,873 tons. This is an increase of 16% over the tonnage of 1,949,028 produced in June, 1952. The output of paperboard grades during the month amounted to 1,056,420 tons, an increase of 25% over the production of 846,294 tons in June, 1952. Paper production amounting to 941,221 tons reflected an 8% increase from the 866,549 tons produced in June a year ago.

Wood pulp production during June amounted to 1,477,347 tons as compared to 1,330,762 tons produced in June, 1952.

1952 Statistics

Final statistics for 1952 show that total United States output of all grades of paper and board amounted to 24,423,000 tons, according to the Bureau of the Census, Dept. of Commerce. This represents a decrease of 6% from the record annual production of 26,048,000 tons in 1951.

The production of paper grades at 10,898,000 tons reflects a decrease of about 6% from the 11,625,000 tons produced in 1951. Newsprint and groundwood paper were produced at the 1951 levels. Decreases were registered by all other major paper grades.

Total output of paperboard amounted to 10,772,000 tons as compared to 11,620,000 tons in 1951, a decrease of 7%. Decreases were shown by all major grades of paperboard except special food board which increased from 773,000 tons to 799,000 tons.

The leading paper and board producing state was New York with 1,736,000 tons. Louisiana and Wisconsin also produced over a million and a half tons.

Wood pulp production amounted to 16,473,000 tons in 1952, remaining at the level of the record 1951 output. Wood pulp inventories at pulp mills rose 47% to 144,000 tons at the close of the year, with the largest increase being in "Special alpha and dissolving grades." The leading pulp producing state was Washington with a production of 2,068,000 tons. Other states producing over a million tons were Florida, Georgia, Louisiana, and Maine.

The consumption of wood pulp in the paper and board industry decreased 3% to a 1952 total of 17,286,000 tons. Wood pulp inventories at paper and board mills at the close of the year amounted to 567,000 tons.

Receipts of wastepaper totaled 7,815,000 tons in 1952. Consumption at 7,881,000 tons slightly greater than receipts and inventories correspondingly dropped 11% to 522,000 tons at the close of 1952.

Wastepaper

The month of August, 1953, established a new record for both the purchase and consumption of wastepaper during the eighth month of all years since the end of World War II.

Wastepaper packers and suppliers have been advised that, in addition to boxes, bags, and wastepaper containing asphalt, polyethylene, and sulphur, which are to be marked with identifying symbols, the paper and paperboard industries will continue to reject wastepapers containing carbon papers, tar, paraffin, cellophane, parchment, wet-strength papers, foil, rags, rubber, wire, and trash.

Several box manufacturers are doing some experimental work, using a sheet of thin aluminum foil on one or both of the liners. This is a material that cannot be reused and packers are being warned against packing it with corrugated or other wastepapers. Wastepaper consumers are doing everything that they can to assist the packers in identifying paper and board that cannot be reused without damage to their products.

Our government has been getting about $100,000 a year by selling the scrap paper from its waste baskets. Now it is figured out how to boost this income to $300,000 or more by

FORMATION

THAT'S OUR JOB

Few of us here at Valley can remember when we haven't lived and slept the daily problems of designing and building Inlets and Headboxes. Our specialization goes back that far.

And we have followed them into the field, observing and refining every detail of performance . . . . . all resulting in a continuously enlarging reservoir of information to assist our mill customers in the making of *better* paper at *lower* cost.

Experience is a great teacher, and we have taken fullest advantage of this practical source of knowledge to serve you.

Better formation is *your* objective.

Better formation is *our* job.

We invite you to submit your formation problems to us for consultation.

Stock Entrance Equipment by

VALLEY
Iron Works Company
APPLETON, WISCONSIN

sorting the paper and selling it according to grade. It is assumed that the income from wastepaper is considerably boosted by the fact that since the government makes everything in triplicate, it also throws it away in triplicate.

Position of the Industry

Prior to 25 years ago the paper and paperboard industry was in 18th position among the first twenty. In 1928 it was in 9th position and in 1953 it is almost in 5th position, being led by (1) motor vehicles and parts, (2) meat packing, wholesale, (3) steel works and rolling mills, (4) petroleum refining and (5) cotton broad woven fabrics. It is followed by (7) sawmills and planing mills, general, (8) flour and meal, (9) bread and pastry products, and (10) prepared animal feeds.

Keyes Fibre

Keyes Fibre Co., Waterville, Me., celebrated its 50th anniversary in September. When the company was founded in Shawmut, Me., by Martin Keyes there was but a single molding machine and about a half-dozen individuals turning out fiber pie plates which Mr. Keyes went about the countryside selling. Now in plants in Waterville, Fairfield, and Hammond, Ind., some six million articles are turned out daily and the line has expanded from the pie plate to some 150 items including plastic products. Employees in the two manufacturing plants and the pulp mill in Shawmut now number about 1000 persons. Companies in Canada, Northern Ireland, England, Denmark, Norway, and Sweden manufacture molded pulp products under Keyes licenses. During the war years one officer in the Army remarked that he never was out of sight of a Keyes plate.

High-Speed Paper Sampling

A number of industries, including paper, textiles, metal, and plastics have a common problem when they need samples during manufacture. High-speed rollers carrying the sheet material have to be stopped so that a piece can be cut out of the strip.

R. W. Maddern and N. E. Norman of the research laboratories of the Australian Paper Manufacturers, Ltd., Melbourne, Australia, have developed a device that cuts a small sample from practically any sheet material while it is moving.

A circular cutter shoots through the sheet so rapidly that even their paper needs no supporting back. The inventors made the cutter circular to minimize stresses in the sheet that might lead to breakage in later processing.

The device is in the form of a gun. A blank cartridge shoots the cutter through the material. Cutter and sample are caught in a cushioned box. When the moisture content of the sample is important, a sheet of foil is placed over the cushioning.

The developers of the new device list two advantages. The sampling position can be located accurately and the sample is removed without any danger of tearing even such fragile materials as thin plastic film or wet paper products.

Ohio Boxboard

Effective in August the Ohio Boxboard Co. operations were grouped in three divisions: (1) the Rittman Production Div. which covers all Rittman, Ohio, production operations as well as the company's two wastepaper subsidiaries (OCO Waste Paper and Akron Industrial Salvage); (2) the Carton Board Div., which covers the sale of all cartons and board produced at the Rittman plant, the operation of the Norwalk carton plant, other carton plans as they may be added, and the expansion generally of the carton and board business; and (3) the Container Div., which includes the sale of all containers produced at the Rittman plant, the operation of the Cuyahoga Falls and Pittsburgh branch plants, and any other container plants which may be added, and the expansion generally of the container business.

National Container

National Container Corp. announced effective September 1 an increase of $5.00 per ton on all grades of kraft liner board and corrugating medium produced at its five mills. When its new mill at Valdosta, Ga., is completed the company will produce 500,000 tons per year.

Harry S. Hemple has been appointed manager of the East St. Louis, Ill., plant. National Container Corp. operates 19 kraft box converting plants.

The following National Container Corp. personnel changes have been announced: Karl M. Guest, the former plant manager at Jacksonville, has been named plant manager at Valdosta, Ga.; J. E. Mailhos, H. M. Burnette, and William J. Miles formerly plant engineer, maintainance superintendent, and master mechanic at Jax, have all been transferred to Valdosta in similar capacities.

New Paper Machines

Ten new paper machines were installed during the past 12 months in the United States and one in Canada.

Stone Container

Stone Container Co., Chicago, Ill., has purchased the mill of the Stone-Mann Paper Co., Crichton, Ala. It purchased the 50% interest of the Seaboard Container Corp. Stone Container Co. and Seaboard Container Corp. have owned the property jointly since 1950.

Forest Fires

Nearly 128,000 forest fires broke out on protected lands in the United States in 1952. The following tabulation shows the causes of these fires: lightning—8012; railroads—3611; campers—5667; smokers—25664; debris burning—25816; incendiary—42440; lumbering—3074; miscellaneous—13710 total—127,994.

Sorg

Claude A. Sorg has been named director of paper manufacturing for the Sorg Paper Co., Middletown, Ohio. Donald J. Goodman has been appointed general superintendent in charge of The Sorg, Oglesby and Smith Mills and Carl H. Eisenmengh has been appointed general superintendent in charge of finishing, traffic, receiving, and standards.

Hartford City

The Hartford City Paper Co. is celebrating its 60th anniversary. Among the first claimed by this fine company are: (1) first company to manufacture glassine in the United States; (2) first to use sulphate pulp in greaseproof for stronger, more pliable papers; (3) first to offer greaseproof for lard carton liners to sharply cut their cost, and (4) first to produce greaseproof parchment-type tracing paper now used in large quantities by artists and designers.

Included in its newly announced products are *Wonderap*, a two-sheet ham and slab bacon wrapper which is strip-glued to act as a single sheet. It replaces the old three-sheet wrapping method, a method that has not been changed in 40 years. *Coil-Kraft* and *Electrical* Glassine Papers used in layer insulation for transformers and coils, and *Photolucent* a photocopying paper which permits faster speeds on photocopying machines, eliminates negatives and produces clearer prints.

Ebasco

H. T. Canfield has been appointed assistant construction manager of the Construction Div. of Ebasco Services, Inc. W. C. Stratton has been appointed superintendent of design.

Scottissue

The Scott Paper Co., Chester, Pa., has announced its new

COMPLETE SERVICE

Design

Installation

Maintenance

Repair

Corrosion-Resistant
TILE TANKS
and
LININGS
for Acid and Alkali Conditions

PULP MILL

SULPHITE

Digester Linings for Calcium, Ammonia, Soda and Magnesia Base
Combustion Chamber, Acid Tower, and Settling Tank Linings
Acid Storage Tanks

KRAFT OR SEMI-CHEMICAL

Combustion Chamber and Absorption Tower Linings
Digester Linings
Bleach Plant Tanks and Linings
Pulp Storage Chests

PAPER MILL

Special Process Chests
Stock Storage Chests
Wire and Couch Pit Linings

CHEMICAL PLANT

Acid and Alkali Storage Tanks
Pickling Tanks
Tower Linings and Packing

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SEMCO

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CANADIAN STEBBINS ENGR. & MFG. CO., LTD. — CASTLE BLDG., MONTREAL, CANADA

industrial wiping papers. The secret of the new wiper lies in its special surface. Each wiper consists of two "perf-embossed" sheets which, through a special process are held tightly together for extra durability. Chemical treatment imparts wet strength.

Trophy Papers

A new paper converting firm, Trophy Papers, Inc., has leased 5000 sq. ft. of manufacturing space in the Parsons Div. of the Holyoke Water Power Co. on Gatehouse Rd. near the dam. The new company has been formed by F. A. Barr, president, and George C. Schmidt, treasurer. For the past 20 years Mr. Barr has been connected with the Holyoke Card & Paper Co. Mr. Schmidt has been connected with the Michigan Paper Co., The Falulah Paper Co., and the Holyoke Card & Paper Co. The new firm will engage in the precision lamination of papers, boards, and various types of films and other materials for the paper trade. High-speed and wide trim will be in operation in October. About 15 people will be employed.

Container Laboratories

Henry J. Howlett has retired as president of Container Laboratories, Inc. He is replaced by Charles J. Zusi who was formerly director of research for Hinde & Dauch Co., Ltd. of Canada. Allyn Beardsell is now manager of the Eastern Div. with headquarters in New York. He was formerly in charge of packaging for the Western Electric Co. Alfred Hoffman is now technical director of the company.

Schweitzer

The Black-Clawson Co. has received contracts from the Peter J. Schweitzer Co. to build a fourdrinier tissue machine for its Spottswood, N. J., mill. The new machine will be built to extremely high precision to produce cigarette and condenser tissues as thin as 0.0003 in., with a maximum tolerance of 0.00005 in. It will be the fifth such machine built for Schweitzer by Black-Clawson.

IPC

Jack Weiner has been appointed Editor of The Institute of Paper Chemistry, succeeding the late Clarence J. West. Mr. Weiner has been employed by the Library of Congress since 1948. Prior to 1948 Mr. Weiner was active both as an organic research chemist and as a literature research chemist.

Hoosier Paper

The Vincennes plant of the Fort Wayne Corrugated Paper Co. has been purchased by the newly formed Hoosier Paper Corp. The original organizers of the corporation are Alvin E. Sandroff, Bert Derdiger and Martin M. Wales, all of Chicago.

AFPI

The American Forest Products Industries, Inc., 1816 N St., N. W., Washington 6, D. C., has issued a new 32-page, pocket size, illustrated booklet "Growing Wood for America." It points out that the forest lands of the United States are the most productive in the world. While they make up less than 10% of the earth's forest area, they produce 50% of the world's lumber, 42% of its wood pulp, and 58% of its plywood. Paper consumption in the U.S.A. is about 13 times greater than the world's average.

Inventions

The U. S. Dept. of Commerce, Washington, D. C. (Publications Section) has issued a booklet "Government Owned Inventions Available for License" ($1.00 per copy). It provides information covering 3658 government-owned patents. One item covers the development of all-glass paper, formerly considered an impossibility, which has unusual filtering and electrical insulating properties, making it suitable for gas masks and electrical equipment.

Wisconsin Forestry

The Wisconsin Silver Anniversary Forestry Conference will be held at the Pfister Hotel, Milwaukee, Wis., on November 30 and December 1. The conference is designed to bring together all organizations, private and government, to view the current forestry problems of Wisconsin and to lay the groundwork for the next 25 years' activity.

Paper, Film, and Foil

Effective with the September issue the name of the *American Paper Converter* was changed to *Paper, Film and Foil Converter*. It is published by the Howard Publishing Co., Chicago, Ill.

Paris Exposition

The Fourth International Paper and Allied Trades Equipment Exhibition will be held from May 1–12, 1954, in the Grand Palais, Paris, France.

Florida U.

The second annual pulp and paper conference of the University of Florida will be held at Gainesville, Fla., on Nov. 4–6, 1953. The general topic for discussion will be the kraft recovery system.

Plant Maintenance Show

The Plant Maintenance and Engineering Show will be held at the International Amphitheatre in Chicago on Jan. 25–28, 1954. The conference will be held concurrently at the Conrad Hilton Hotel.

Resources of the Future

The Mid-Century Conference on Resources for the Future will be held in Washington, D. C., on Dec. 2–4, 1953. Detailed information may be obtained from Resources for the Future, Inc., 504 Stonleigh Court, 1025 Connecticut Ave., N. W., Washington, D. C. The conference will cover Competing demands for Use of Land, Utilization of Land Resources, Water Resources Problems, Problems of Nonfuel Minerals, Energy Resources Problems, World Supply and Availability, Problems in Resources, Research, and Patterns for Cooperation.

Brazil

The Brazilian government Trade Bureau has announced that Brazil is planning to build three large pulp and paper mills along the Amazon River. The mills, as planned by Brazil's Ministry of Agriculture and its Northern Agriculture Institute, would each have a daily capacity of 1000 tons of pulp. Raw materials for wood pulp manufacture would be selected tropical timbers little used for that purpose in the past.

Forest Lands—Maine—S.B. 36

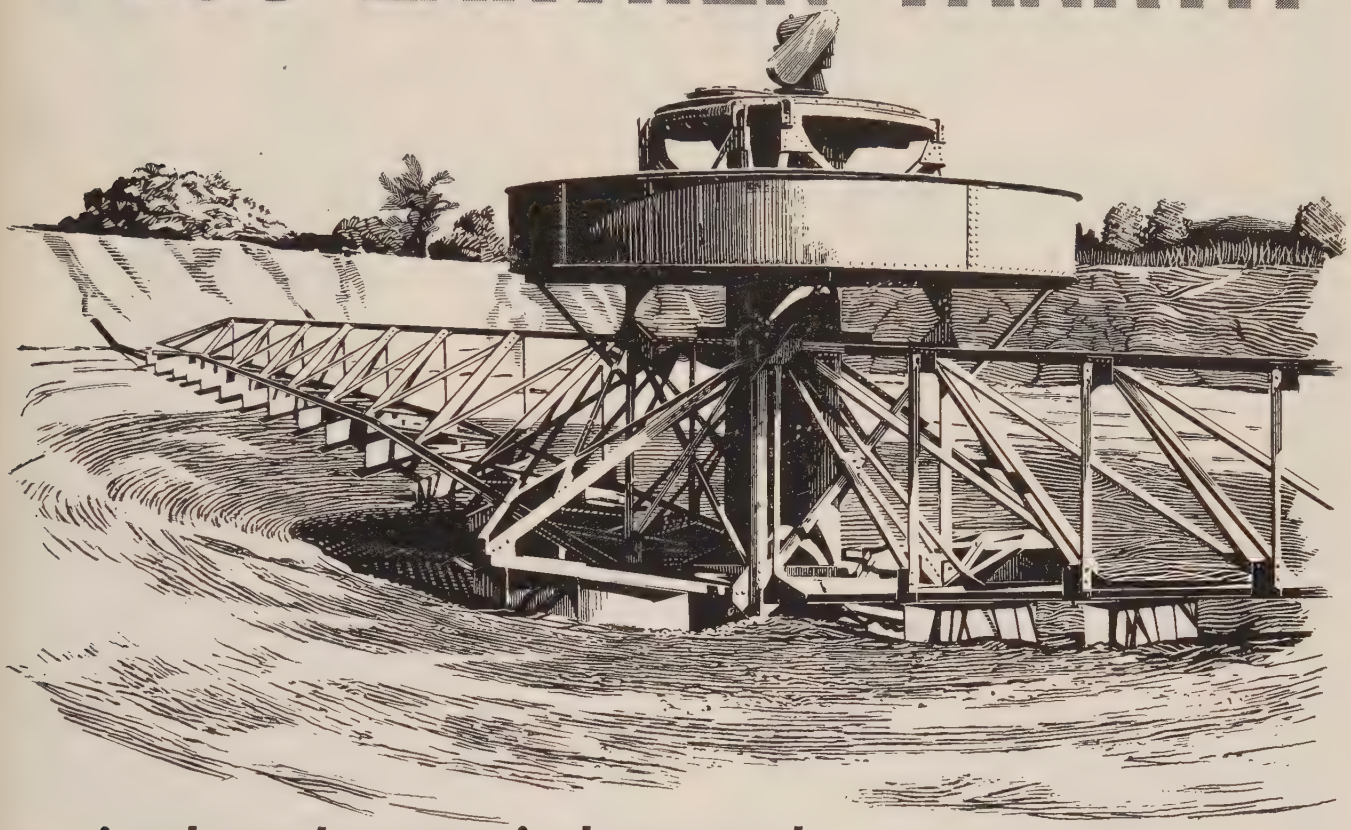
This bill, approved March 31 and effective August 8, provides that the owner of forest lands in Maine may get a tax abatement by presenting proof that the tax rate will prevent his obtaining an adequate annual net return on a sustained-yield basis.

Australia

Two large British paper manufacturers are to undertake a joint project to manufacture fine papers in Australia. The mill, to be named Shoalhaven Paper Mills, will be located near Nowrs, New South Wales, and is expected to be in operation within 3 years.

DORR CLARIFIER

PLUS EARTHEN TANK...



simple and economical approach to pulp mill waste treatment

If removal of settleable solids from large flows is your principal waste treatment worry, this is your combination for economy. A Dorr Clarifier installed in an earthen tank will give you substantial removals of suspended solids and effect reasonable BOD reduction as well — at a lower installed cost than any other available unit.

The principle of installing a Dorr mechanism in an oversized earthen basin has been thoroughly proven in sedimentation operations in many industries. And now . . . three Southeastern kraft mills are adapting it for waste treatment. These particular installations range in size from a 150′ dia. Clarifier installed in a 250′ dia. basin to a 300′ dia. unit installed in a 500′ dia. tank.

While the Dorr Clarifier-earthen basin team is suited principally for use as a primary treatment unit, it's a sound starting point for eventual complete biological treatment as well. Additional treatment steps can be added as needed, without affecting the initial Clarifier installation.

We'd be glad to talk to you or your engineers about the details of this low cost combination in terms of your own problem. No obligation, of course. Just write to The Dorr Company, Barry Place, Stamford, Conn.

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Finland

Metsäliiton Selluloosa Oy, a cellulose company established in February by private forest owners in Finland, bought the Äänekoski Mills from the Wärtsilä-Concern in the last week of July. The mills comprise a sulphite pulp mill, a mechanical pulp mill, a paper and board mill, a sulphite alcohol factory, a chemical factory, and a sawmill. In addition the Äänekoski Mills are the owners of some 28,000 hectares (about 70,000 acres) of forest land. The annual production of these mills has been 20,000 tons of bulky newsprint, novel printing S/C and M/F mechanical printing, 3500 tons of white woodpulp board and sulphite duplex, 40,000 tons of sulphite pulp, 20,000 tons of dry weight white mechanical wood pulp for the mills' own consumption, about 3500 stands of sawn timber and in addition considerable quantities of sulphite alcohol, acetic acid, sizing, and other chemical products.

Sending Best Wishes

Sales of greetings cards have had a fourfold increase in four years. The traffic between well-wishers seems destined to reach a new high sales volume of $350,000,000 for cards of every description in 1953, up 15% from last year. It is a year-round business, although Christmas cards account for 45% of the output of the 300 firms in the industry. The Hallmark firm has embarked on a big plant expansion which includes art gallery, greenhouse, and zoo to give atmosphere for its artists and writers. Women buy some 80% of the greeting cards, so the Norcross firm is attempting to increase its sales to men through use of masculine motives. And Uncle Sam has a considerable indirect interest in this business with millions of cards sent each year at a postage cost estimated at $80,000,000.

Alaska Mill

The Pacific Northwest Timber Co., Portland, Ore., plans to build a $4,502,570 sawmill and pulp chip plant near Wrangell, Alaska.

United Paperboard

A 65-in. ream cutter and a laminating machine are now being installed in United's paperboard mill at Thomson, N. Y.

A smaller ream cutter at Thomson which was used for cutting small sizes and trimming pasted board was overtaxed by the increase in pasted board turned out at the mill. The new cutter is being installed in the machine room which should help considerably in speeding up the delivery of orders which, for various production reasons, have been doubled in length on the machine.

The laminator which is being set up in another building will permit the Thomson mill to manufacture pasted chipboard from rolls which will mean faster operation than the present sheet paster. It will also make it possible for Thomson to manufacture pasted specialty lining boards much more easily and will permit the mill to go into the specialty lining field which prior to this it has been unable to do.

The laminator is 62 in. wide and approximately 85 ft. in length. It can be operated using six rolls at one time, and can laminate sheet of patent coated with chip center and black back, 120 points or more in thickness.

Buckeye

A great movement has been taking place around Sandy Hill. It might be called Operation Exodus Buckeye. It has involved the dismantling, crating, and shipping of the 180-in. removable fourdrinier and auxiliaries designed and built in recent months as part of the contract for equipment to be installed in the $9,000,000 mill now being built at Foley, Fla., by Buckeye Cellulose, a subsidiary of Procter and Gamble.

The Kamyr vacuum washers and auxiliary items for the pulp bleaching system are still in the shop but fast nearing completion.

All of the equipment will be a vital part of a cellulose pulp plant, covering 54 acres and expected to start operation in the Spring of 1954. When those operations begin, the plant will employ almost 500 people. It will have a capacity to use approximately 750 cords of wood a day to produce 300 tons of cellulose dissolving pulp. This pulp will then be used as a raw material in a variety of products, rayon, plastics, films, quick-drying paints, and cellulose derivatives.

Forty flat cars will be required to carry to Foley the machinery built at Sandy Hill Iron & Brass Works.

A listing of cold statistical facts on the weights and sizes of the machinery and the requirements to feed a giant such as the Buckeye machine is too staggering for comprehension by others than those close to such an operation. But, a comparative study of some of these figures proves very interesting.

The flow system to the machine has a capacity of 9600 gal. per minute or a daily consumption rate of 13,800,000 gallons which is approximately 18 times as much as that used by the entire village of Hudson Falls in a day.

Engineering calculations are another set of staggering figures. We are told that the calculations for the press section alone cover some 150 pages.

South's Pulpwood

In 1952, for the third consecutive year, the South's pulpwood harvest topped all previous records. The total cut was 14,564,800 cords, nearly 4% more than in 1951 and 17% greater than in 1950. Pine made up 12,782,600 cords of the total, hardwood 1,691,100 cords, and dead chestnut 91,100 cords. Hardwood cordage was up 17% over 1951, pine up about 3%, and chestnut down 46%.

Since total U. S. pulpwood production in 1952 was 25,045,000 cords, the South supplied 58% of all the pulpwood cut in this country. All southern States except Arkansas, Tennessee, and Oklahoma produced more than a million cords apiece. Georgia was first with 2,513,000 cords, Mississippi second with 1,865,000, and Alabama third with 1,583,000. Thirty-nine counties, distributed throughout the region, had cuts of more than 60,000 cords each.

At the close of 1952, there were 63 pulp mills in the South, with a total capacity of 26,865 tons of pulp per day. Six new mills, with a projected capacity of 2360 tons daily, were building.

Nepco

Using a process never before tested on a mill scale, Nekoosa-Edwards Paper Co. is just completing a series of tests of a pulping method which it is hoped will reduce stream pollution from sulphite pulp mills.

The ordinary sulphite pulp mill uses limestone as a base for its cooking chemical. This material is efficient and inexpensive. Unfortunately, the spent cooking liquor is extremely difficult to process because the lime in it scales up heater surfaces and piping just as lime cakes on the inside of a teakettle. For this reason spent sulphite liquor has traditionally been discarded.

The method being tested by Nekoosa-Edwards uses ordinary lye in place of limestone. This process, known as soda-base cooking, can be employed only if the costly chemical can be removed for reuse. Engineers from Western Precipitation Corp. of Los Angeles, which owns a recovery process for the soda, are working closely with the paper company's technical and operating staff. This process appears to be technically feasible but until now has not undergone critical mill-scale evaluation.

So far Nekoosa-Edwards has manufactured about 500 tons of sulphite pulp by this soda-base process. Limited success has been attained in processing the resultant liquor so that it could be burned with recovery of heat and chemicals. Since none of the liquor processed is discarded, this method, if

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ROBERTS GRINDER

We are now building the Roberts Grinder, incorporating many new features of improvement that means greater operating efficiency, rugged and quality construction, greater production, less H. P. per ton of pulp and higher brightness. New control features means obtaining practically any type of pulp desired. Roberts Grinders are available in three sizes to take 2-foot, 4-foot, and 5-foot wood.

ROBERTS GRINDERS BUILT PREVIOUSLY — We also wish to announce we have blueprints and patterns available to service your requirements on maintenance and parts of any previous grinders built.

ROBERTS GRINDER *Advantages and Savings* FOR YOUR MILL... Greater production — up to 50 tons a day per grinder • Replaces 3 to 4 pocket grinders • Saves up to 50 percent floor space • Greater grinding area permits more pulp per unit • Less waste • All-enclosed operation eliminates steam and vapor • Fits existing buildings with normal headroom • More uniform, higher quality pulp • Higher brightness • Less H. P. per ton.

Your inquiries are invited for a survey application of the IMPROVED Roberts Grinders to your mill requirements.

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successful, would be highly effective in reducing stream pollution.

Company executives report that the experiments are encouraging but by no means conclusive. It is hoped that more tests will disclose how to reduce the cost of the process to such a point that it can be used.

Other soda-base sulphite processes have been tried out on a limited scale. Two mills in Europe, where economic conditions are greatly different from Wisconsin, are using such processes, and it is reported that they have been successful in recovering the valuable sodium.

Dry Broke

Little piece of dry broke, lying on the floor,
Innocent piece of dry broke, that and nothing more.
Will somebody pick you up to make the place look neater,
Or will you soon be contaminating a nice, broke beater?
Bronze and rubber size press, traveling sixteen-twenty,
Have you seen any dry broke? You say that you've seen plenty!
Crash! Bam! Crush! Wham! Your embosser rolls are battered.
Hardy piece of dry broke, just a little tattered.
Oh, you tired Millwrights, Are you all in bed?
You had better kiss your sleep good night and go to work instead.
Your Foreman is on the telephone. Can't you hear it ringing?
Do not raise your voice so loud. This is no time for singing.
Oh, you patient printers, waiting for your paper,
It was slightly overdue, now it will be later.
No, we didn't run out of wood. Yes, we know you're sore.
It was just a piece of dry broke—that, and nothing more.

—Hammermill Bond

Rhinelander

The first full-scale evaporation plant in America for processing sulphite wood solids extract into useful by-products set a new all-time production record recently when total output of the concentrated wood extract manufactured since the plant started up last November reached 1,000,000 gal.

Officials of Rhinelander Paper Co. held an informal celebration of this achievement that marked the success of the new project. The paper firm built the evaporator plant based on utilizing technical data developed by the Sulphite Pulp Manufacturers' Research League of Appleton. The company built the evaporator plant in order that the material dissolved out of pulpwood chips in its sulphite pulping process may be put to good use instead of flowing into the river.

The one-millionth gallon, along with 2999 other gallons of the concentrated product, was shipped to a large Wisconsin chemical manufacturing company. A substantial fraction of total output of the Rhinelander unit since the plant went into production has been sold to this concern as raw material for a wide variety of chemical products ranging all the way from food flavoring to ingredients for storage battery plates and agricultural chemicals. Approximately half of the Rhinelander evaporation plant's output since November has been sold to various industries as raw material for assorted products. The rest of the concentrate has been burned in the Rhinelander mill's boilers as industrial fuel, replacing coal which otherwise would have been purchased.

In the evaporation process, 7 gal. of water are boiled away to produce 1 gal. of the concentrated extract, containing 50% wood solids content. Thus, manufacture of 1,000,000 gal. of concentrate means that 8,000,000 gal. of the dilute fluid did not flow into the Wisconsin River.

West Virginia

Combination of West Virginia Pulp and Paper Co. and The Hinde & Dauch Paper Co. was recommended by the boards of directors of the two companies at separate meetings held August 21. The action is subject to necessary stockholder acceptance.

On the basis proposed, shareholders of Hinde & Dauch will receive for each of their shares, one and one-third shares of new West Virginia common stock, after a four-for-one split of its present common.

Hinde & Dauch is to be operated as a subsidiary of West Virginia Pulp and Paper Co. with the operations, personnel, and customer relationships of the two companies continuing as they are at present.

West Virginia's board voted to recommend to stockholders, for action at a special meeting to be held this Fall, splitting the present common stock on a four-for-one basis. It also recommended that the new stock should have a par value of $5.00 per share, and that the authorized shares be increased to 7,500,000.

The proposed combination would bring together two old and well-established firms in different segments of the paper industry. West Virginia is the leading manufacturer of paper and paperboard in this country which does not convert paper and paperboard into end products. Hinde & Dauch is the largest manufacturer of corrugated shipping containers which does not manufacture its entire requirements of paperboard.

Founded as a pioneering venture in the production of sulphite pulp 65 years ago, West Virginia Pulp and Paper Co. grew to become one of the best-known producers of book and magazine paper. In the past 20 years, the company has diversified to a broad degree, while maintaining a relatively stable position in the white printing and fine paper fields. Today it is one of the important manufacturers of such grades as kraft liner board, corrugating board, kraft paper, and white converting board used in the packaging and food container fields. The firm operates six mills in five states, with a capacity of more than 800,000 tons per year. Net sales in 1952 amounted to $108,933,000, for a net profit of $9,471,000.

Hinde & Dauch, the first manufacturer of corrugated boxes in this country, now operates in the United States 12 box factories, producing close to 3,000,000,000 sq. ft. of board products per year, and three paperboard mills producing well over 80,000 tons per year. Hinde & Dauch reported net sales of $43,118,000 for 1952 and net earnings, after taxes, of $3,132,000.

In Canada, Hinde & Dauch owns a majority interest in Hinde & Dauch Paper Co. of Canada, Ltd., which owns and operates two paperboard mills with an annual capacity of 100,000 tons, and three box factories with a production of about 1,000,000,000 sq. ft. per year. West Virginia recently purchased a partially integrated corrugated container plant in Brazil. In each case the foreign subsidary accounts for about 30% of the output of its type of products in the country in which it operates.

Hinde & Dauch maintains central offices in Sandusky, Ohio, which serves as the center for the operation of a chain of modern plants located in strategic market areas throughout the industrial East, from Massachusetts to Virginia; the Great Lakes area, and the Midwest. In the new setup, Sandusky will continue to be headquarters for Hinde & Dauch.

Plant sites include box factories at Baltimore, Md., Buffalo, N. Y., Chicago, Ill., Cleveland, Ohio, Detroit, Mich., Gloucester, N. J., Hoboken, N. J., Kansas City, Kans., Richmond, Va., Sandusky, Ohio, St. Louis, Mo., and Watertown, Mass., and paperboard mills at Gloucester, N. J., Fort Madison, Iowa, and Sandusky, Ohio. These operations employ a total of 2870 persons.

The Canadian subsidiary operates paperboard mills at Toronto and Trenton, Ont., and box factories at Toronto and Chatham, Ont., and Montreal, Que. The Canadian organization employs 1120 persons.

Hinde & Dauch has an able and experienced sales force which covers the eastern and midwestern sections of the country from offices located at all of its factories.

The company manufactures a wide variety of high quality corrugated shipping containers and solid fiber boxes which it supplies to a broad list of customers engaged in practically all phases of commerce and industry. It maintains a package engineering laboratory and carries out a continuing

Quality Paper Making calls for OK BRAND STARCHES

for tub, beater and calender sizing—
for coating and adhesives

FREE TECHNICAL SERVICE!

Some of the industry's outstanding experts in the use of starch in paper making are on the staff of Hubinger's famous laboratories. You are invited to consult these experts on your production problems—without cost or obligation on your part.

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packaging development program while maintaining complete design and art facilities to serve its customers.

At Dec. 31, 1952, Hinde & Dauch's balance sheet showed total assets of $27,767,000. The authorized capital consists of 1,750,000 shares of common stock, of $10 par value, 952,758 of which were outstanding as of that date. The company has a total of 2800 common stockholders.

West Virginia Pulp and Paper Co. has its main offices in New York City, and maintains sales offices in New York, Chicago, and San Francisco. New York also is headquarters for the company's Industrial Chemical Sales Div., which markets a variety of chemical products through sales offices in New York, Philadelphia, Cleveland and Chicago.

West Virginia's balance sheet shows total assets of $149,704,000, as of Oct. 31, 1952, the end of its last fiscal year. The outstanding stock of the company consists of 116,824 shares of cumulative preferred stock of $100 par value and 902,432 shares of no-par-value common stock, which, on the proposed four-for-one split, will become 3,609,728 shares. The company has a total of 3000 common stock holders and more than 1200 preferred stockholders.

The company's plants, operated at Charleston, S. C., Covington, Va., Luke, Md., Mechanicville, N. Y., and Tyrone and Williamsburg, Pa., employ a total of 8200 persons. Each of the plants has its own water system, steam and power plants, and chemical operations, as well as pulp and paper manufacturing facilities. The company has spent more than $92,000,000 on expansion and modernization projects since the end of World War II.

Three research and development laboratories, devoted to all phases of pulping, papermaking, and chemical studies, are operated by the company at Luke, Md., Tyrone, Pa., and Charleston, S. C. The company also operates at Covington, Va., a modern pilot plant designed to produce all types of papermaking and dissolving pulp.

Engineering divisions are maintained at the company's main offices in New York as well as at each of the mills. Each division is staffed and equipped to conduct engineering development studies.

The company owns and manages more than 750,000 acres of timberland, mostly in North and South Carolina, which are operated in accordance with modern scientific tree farming methods to provide continuing yield and regrowth. The company's forest management program includes such activities as soil analysis and evaluation, drainage projects, road construction, sylvicultural research, forest genetics, and fire protection and suppression.

As part of its forestry development program, the company maintains a 20,000-acre experimental forest in South Carolina, where broad studies in modern forest techniques are carried out.

Bird & Son

Bird & Son, Inc., will build a $2,250,000 roofing plant and granule plant at Charleston, S. C. Forty-eight acres of land have been purchased at Stark Industrial Park on the Ashley River. Construction will start this Fall and the plant is expected to be in operation by next Summer.

It will employ 150 people and will serve the Southeast, particularly the Carolinas, Virginia, Tennessee, Georgia, Florida, and part of West Virginia.

A modern roofing machine will be built 500 ft. long, the longest machine in the country. It will have all the latest refinements for fast and efficient production of a full line of quality asphalt shingles and roll roofings. The plant will also produce plastic cements and roof coatings. The building to house the equipment will have a floor area of more than 100,000 sq. ft. It will be 900 ft. long and vary in width from 60 to 160 ft. Included in the plans is a warehouse with 42,000 sq. ft. of storage area.

Adjacent to the roofing plant, a granule plant of 6000 sq. ft. is being built. This will crush and color the surfacing material for Bird shingles and roll roofings. A boiler plant is also being constructed. Space has been provided for future plant expansion when required.

Because of the intricate nature of the machinery and the company's desire to incorporate all the special mechanical features found in present Bird roofing machines, as well as many new features, the engineering work is being done by Bird & Son engineers. Under the direction of Vice-President E. L. Chamberlain, William R. Wright, Jr., engineer and superintendent of the Norwood, Mass., roofing plant is in general charge of the planning and layout. He and David Fleming, plant engineer, have designed the roofing machine and its equipment. Other Bird & Son engineers who are working on the project include: Herbert Davis, Nelson Bartlett, Stanley H. Sallie, Leonard W. Weaver, Howard C. Bearce, Joseph Sheehan, Oscar Lambine, John Callan, and Russell Pulsifer.

Bird & Son is one of the oldest American industries, established in 1795. It was one of the first companies to pioneer in asphalt roofing manufacture, and has been making quality roofings since the 1880's. The company's founder was George Bird of Union, Me. He built his first paper mill in Needham, Mass., and in 1812 moved a short distance to East Walpole, Mass., the present location of the Bird & Son home office, paper mills, and box factories. Here the company produces solid and corrugated fiber shipping containers, shoe cartons, paper flower pots and plant bands for horticulturalists, and many papers for special purposes. Other paper division plants are located in Manchester, N. H., and Auburn, Me.

Roofing mills are located at Norwood, Mass., Chicago, and Shreveport, La. Felt mills are at Phillipsdale (East Providence), R. I., and Shreveport, La. Granule plants operated at Norwood and Glenwood, Ark. Insulating board is produced at Phillipsdale and used for the manufacture of insulating sidings at Norwood and Chicago.

A floor covering plant in Norwood produces Bird felt base floor coverings and linoleum sold in all 48 states and in Canada and Hawaii.

Berry Asphalt Co. of Magnolia, Ark., with refineries at Waterloo and Stephens, is a wholly owned subsidiary. Bird & Son is one of three owners of the newly formed Rubarite, Inc., which will produce material for rubber roads and other industrial purposes at a plant in Ark.

Bird Machine Co. of South Walpole, Mass., manufacturer of paper mill machinery and centrifugal machinery, is a partially owned subsidiary.

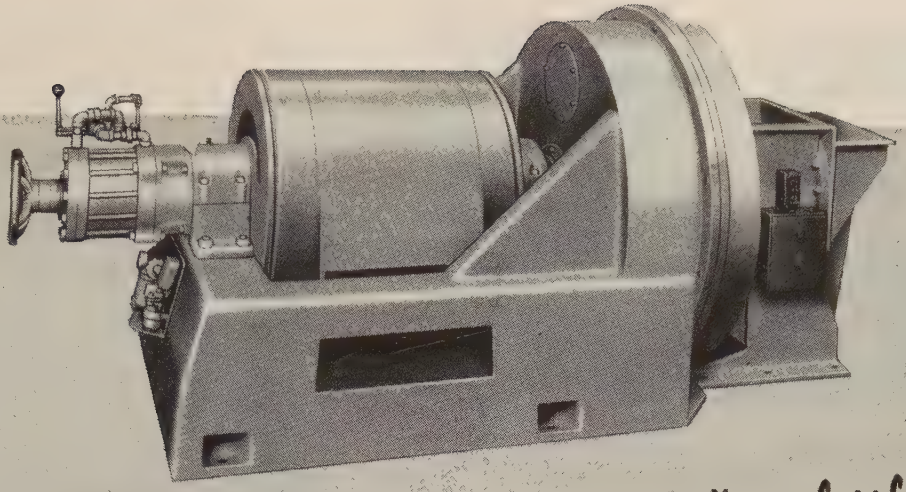
Officers of Bird & Son, Inc., are president, Axel H. Anderson; vice-president Building Materials Div., Eli L. Chamberlain; vice-president Floor Covering Div., H. Eugene Sawyer, Jr.; vice-president Paper Products and Felt Div., Ralph A. Wilkins; treasurer and secretary, Wesley C. Ahlgren. Charles S. Bird, Jr. great-grandson of the founder, is chairman of the board.

Northern Paper Mills

Promotion of three staff men to positions of increased responsibility at Northern Paper Mills, subsidiary of Marathon Corp., went into effect August 1.

John E. Goode, formerly assistant chief engineer, is appointed to the newly created position of assistant general superintendent. In this capacity, he will assist general mill superintendent E. E. DenDooven in supervision of general plant operation. Goode has been at Northern since 1947, serving first as a project engineer, next as master mechanic, then as assistant chief engineer. Goode is a Purdue University engineering graduate and a registered professional engineer (Wisconsin).

Appointed to succeed Goode as assistant to H. W. Gochnauer, chief engineer at Northern, is Robert L. Cowles, Jr. Cowles joined the engineering staff of the company in 1948



something NEW has been added to the BAUER line of refiners

No. 510 — a precision single revolving disc machine

With this great new refiner, you can keep abreast of the trend toward pulp processing machines of greater capacity.

The No. 510 has a rotating disc and a stationary disc, each 40″ diameter. Maximum power input is 450 hp. Speed range is 750 to 1,450 r.p.m.

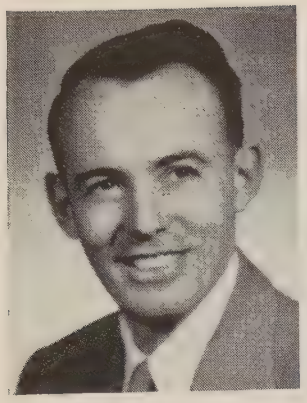
Experience in upwards of 175 mills with more than 500 Bauer double and single disc refiners has conclusively demonstrated the success of these machines in processing all recognized types of fibrous materials used in the pulp, paper, board, and felt roofing industries.

The Bauer No. 510 machine is particularly useful for reducing bulky and stringy materials in wet or dry condition and for refining low density pulps. End results are largely determined by the kinds of plates used. These are available from us in many patterns and in a variety of alloys as well as abrasives.

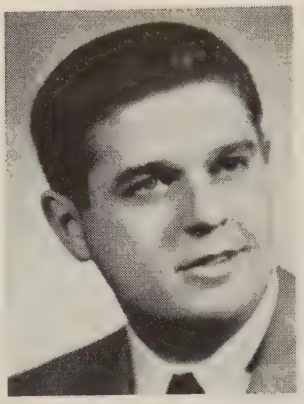
Specifications of the No. 510 Refiner are stated in our Bulletin No. P-10. Ask us for it.

THE Bauer BROS. CO.

1715 SHERIDAN AVE. • SPRINGFIELD, OHIO



John E. Goode, Northern Paper Mills



Robert E. Cowles, Jr. Northern Paper Mills

shortly after graduation from Northwestern University with a degree in engineering, and was advanced to the position of master mechanic late last year.

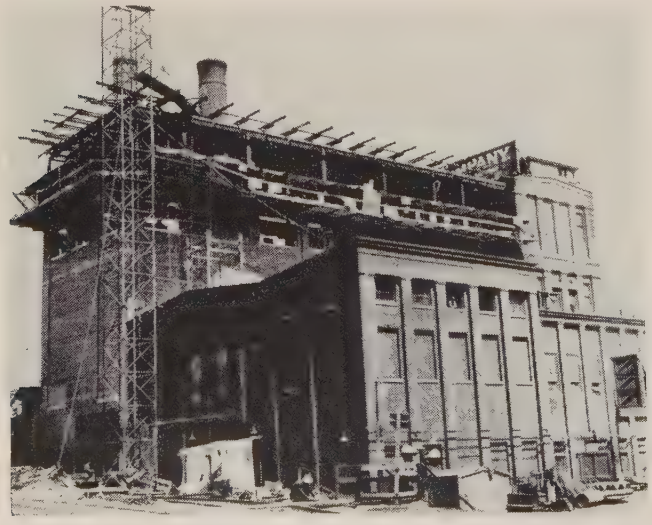
Completing the realignment of assignments at Northern is assumption of all responsibilities over plant maintenance and engineering shop functioning by Royal Robillard as master mechanic. This position was previously the joint responsibility of Cowles and Robillard. A 38-yr. veteran at Northern, Robillard has served as master mechanic for approximately the past seven years, and was machine shop foreman prior to that.

Oxford

One big project now underway at Oxford Paper Co., Rumford, Me., is a redevelopment of some of Oxford's hydroelectric power sources by the Rumford Falls Power Co. Just one phase in the expansion and improvement program for which Oxford has earmarked $12,000,000 for the next five years. Already $20,000,000 has been invested in the program since it began shortly after World War II.

Redevelopment of the hydroelectric power sources involves the erection of a new power station on the bank of the Androscoggin River adjacent to the Oxford mill. The 80-ft. head development will be supplied with water by two 1000-ft. long, 12-ft. in diameter penstocks, thereby combining the present 30 and 50-ft. head plants into one station.

The new power plant, when completed in 1954, will house two 9000-hp. water wheels which will be connected directly to two 6400-kw., 60-cycle electric generators. Construction of this hydroelectric power system also involves conversion of some of Oxford's electrical equipment from 40 to 60-cycle frequency. This power project will be completed in 1954.



New hardwood kraft bleach plant now under construction by the Oxford Paper Co., at their mill in Rumford, Me.

Another major project in the expansion program, begun in December, 1952, and slated for completion by the end of this year, is the installation of a new hardwood kraft bleach plant. When finished it will represent one of the most modern plants of its kind in New England. This kraft bleach plant will be housed in a brick and glass block structure 45 ft. wide, 132 ft. long, and 165 ft. high.

During the past six months Oxford has completed seven projects in its multimillion dollar expansion program. Finished this May was a four-story brick and glass-block structure, built as an annex to the firm's supercalendering building. The annex provides a basement to house electric generators and related equipment, a second floor for the expansion of supercalendering operations, a third floor for the research department offices and an expanded technical library, and a fourth floor to provide a new drafting room for the Oxford engineering department.

Charmin

Volume production of torula yeast and greatly expanded facilities for its sale and distribution and for researching its full potential as an ingredient in human foods, animal feed, and as a basic material for pharmaceuticals is now virtually assured as the result of an agreement signed here recently between two long-established Wisconsin companies.

Details of the venture, unique in the yeast business, were announced jointly by Russell D. L. Wirth, president of the 70-yr.-old Red Star Yeast & Products Co. of Milwaukee and J. M. Conway, president of Charmin Paper Mills, of Green Bay, Wis., established in 1892 as the Hoberg Paper Mills.

Unlike the more familiar active yeasts used in baking and brewing, torula yeast is not a leavening agent but is an inactive yeast of purely nutritional value. It differs from other yeasts, also, in that it is made in a continuous propagation process which is revolutionary to the yeast industry. Also, torula yeast has a characteristically pleasant taste and does not require debittering.

Long known to scientists as extremely rich in vitamins and proteins, torula yeast is derived in a continuous process from tree sugars extracted from wood solids otherwise unused in pulp and paper manufacturing. First commercial production of the new yeast dates back only to World War II when Germany, Scandinavia, and other European countries, cut off from Western Hemisphere meat supplies, produced torula in plants built and operated during the emergency by their pulp and paper industries, and used it to supplement the vitamin and protein requirements in their national diets.

At about the same time American scientists, in behalf of the pulp and paper industries in Wisconsin, were studying the subject and by 1948 had progressed to the point where an experimental plant with an annual production of almost 3,000,000 lb. of torula yeast was built and put into operation near one of the Wisconsin pulp and paper mills. This plant, which was subsequently taken over by the mill, is still operating and represents the only immediate source of torula yeast in the United States.

Meanwhile, subsequent tests in the United States were establishing the efficiency of torula yeast as a food supplement for humans as well as poultry, fur animals, and game fish and results of the most recent research work on torula by scientists in American universities further strengthened the new yeast's standing with nutritionists generally.

As a means of providing for the American market the first major source of torula yeast in dependable, continuing supply, the Charmin Paper Mills has under construction a new torula yeast producing plant adjacent to their mills at Green Bay. The new plant will have a production capacity of at least 10,000,000 lb. of torula yeast annually, processed according to the most modern methods so far developed. Meanwhile,

DOWN TIME

and out ... for Bacillus Subtillus

This Huyck Brochure on mildew-proofing is important to you and it's yours for the asking. It explains how the problem of mildew-making microbes which damage papermakers' felts is solved with DEWPRUF... the treatment that *permanently* resists the action of Bacillus Subtillus and his destructive cousins found in *every* water system. Write Department 19 for this free Brochure and discover how DEWPRUF can save you many, many down-time dollars by extending the life of your felts.

KENWOOD TEXTILE PRODUCTS

HUYCK FELTS

First in quality... first in service.

© Copr. F. C. HUYCK & SONS, 1953

F. C. HUYCK & SONS • ESTABLISHED 1870 • RENSSELAER, NEW YORK

the extensive research facilities of Red Star Yeast & Products Co., which alone, and in collaboration with research scientists and universities has pioneered many substantial advances in yeast technology, yeast products, and yeast quality control, will begin researches in torula yeast with a view to developing additional new uses and a full line of products.

Both Red Star and Charmin have long experience in merchandising their products in the food and drug fields. Red Star is the world's leading producer of active dry yeast and makes and markets a full line of yeast products. Charmin is one of the four largest manufacturers of personal use tissues. It markets through retail stores its nationally advertised Charmin brand toilet tissue, kitchen towels, facial tissues, and paper napkins as well as its Fashion brand facial quality toilet tissue, and sells through paper merchants and other wholesale channels its Evergreen brand institutional line of towels, toilet tissue, and paper napkins.

"The Red Star-Charmin venture has focused on Torula the most advanced facilities of American research science," Wirth and Conway said in their announcement. "Already these laboratory studies have yielded major improvements in taste and purity, and have developed some new marketable products."

Why Advertise

Take a Brown Co.—or any other—advertisement appearing in a magazine. Nothing too difficult . . . pictures, either drawing or photographs, a few paragraphs about the product, and there you have it. Ought to be able to do that in a week or so . . . but, that's not the story. How it's done will be found in a future issue, for right now we are concerned with why it's done, and what type of advertising we use.

First off, advertising, whether it be in the form of a magazine ad, a booklet, a folder, etc., is a sales aid. It is designed to reach those who directly buy or influence the buying of Brown Co. products. Actually, these messages reach thousands of people who are important in buying and whom our own sales force cannot hope to contact for various reasons. In one industrial plant alone there may be a half-dozen or more men concerned with the purchasing, for example, of Nibroc towels. Some read one magazine, others a second or a third; so Brown Co. tells the story frequently through several magazines in order to reach as many of these key men as possible.

Since Brown Co. products reach so many fields, we use a variety of magazines, many in the classification known as "trade journals," and are of interest only to people in a particular industry. Each industry in the country has a number of these publications, and so we use such magazines as *Boot & Shoe Recorder* for Onco, *Electrical World* for Bermico conduit, *American Paper Converter* for Nibroc papers, *Pulp & Paper* and *Tappi* for pulp, and so on.

In addition to the advertising of specific products for various industries, Brown Co. has a general story to tell. It wants Brown Co. to be widely known for the important role it plays in nearly everyone's daily living, and so national publications are used. The *Saturday Evening Post* and The *New Yorker* are utilized for this purpose. Thus Brown Co. and its products become widely known, and our salesmen throughout the country report that advertising of this type has helped make their job easier. In brief, Brown Co.'s advertising of towels, toilet tissues, sewer pipe, and other products helps to create a mass market. Mass markets mean mass production—more jobs for all of us.

Brown Co.'s advertising is designed not only to create user acceptance, but to influence those distributors who handle our items. For example, Bermico sewer pipe is sold through plumbing and heating jobbers and lumber dealer outlets. Nibroc towels and tissues are sold through wholesale paper merchants. To provide these firms with sales aids, various advertising material is prepared during the year. Folders, broadsides, catalogs, and so on.

The distribution of this material to our jobbers and dealers and making sure they use it effectively, is the responsibility of our sales promotion manager. He also makes certain these same people effectively use our advertising as sales tools. Dealers are shown how to make use of reprints of Brown Co. advertisements, using them as direct mail pieces, and how to properly use the wealth of material supplied them each year. Brown Co. is anxious to help these distributors build their sales volume, for it reduces our costs.

Let's look at it this way . . . assume that a distributor buys small quantities from us four times a month. That means we must handle his merchandise four times, and invoice him four times in the course of a single month. If his sales grow and we can ship him a carload once a month, our handling and billing costs are substantially reduced.

You will note that each Brown Co. advertisement asks the reader to send for further information and samples. Unlike a consumer product, such as a shirt or a fishing rod, which you might order by mail, industrial products are rarely purchased sight unseen. Therefore, our ads are carefully keyed so that when inquiries are received we know exactly which ad attracted the reader, and in which magazine it appeared. Hundreds of inquiries are received during the course of the year. Some mighty interesting ones, too, and from some very well-known concerns.

Naturally every inquiry does not represent a "red hot prospect." These inquiries are turned over to the sales divisions and their sales forces for screening and follow-up. Among some of the inquiries received during the past few months are ones from Radio Corporation of America, Max Factor & Co., B. F. Goodrich Co., U. S. Rubber Co., as well as those from numerous private and public schools and city officials.

In the foregoing paragraphs we have described very briefly what Brown Co. does in the way of advertising and why. It is a great deal more complicated than it appears here. The mechanics of producing magazine ads, promotional material, etc., is not simple, nor is it accomplished overnight.

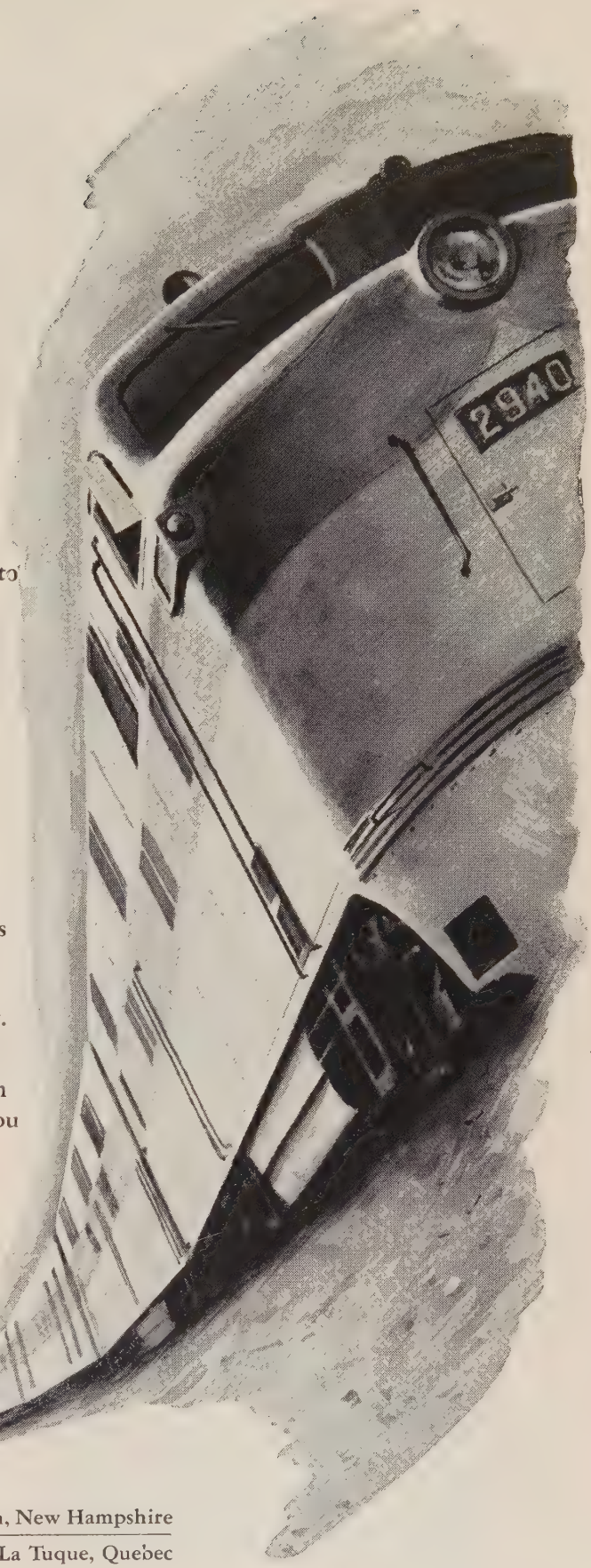
Today's Papyrus

Continuing research has kept the pulp and paper industry flourishing, and will contribute substantially to its future growth. Despite the advent of plastics and other new materials, the pulp and paper industry ranks sixth in value of goods produced, with an annual output worth $6 billion. Annual U.S. consumption of paper and paperboard is now about 31 million tons, 14 times as much as in 1900. Some experts believe that it may reach 42 million tons by 1960. While sales of some paper products are closely related to population growth and business conditions, new developments from research promise a steady increase in the per-capita consumption of many others.

Packaging now accounts for about 45% of the paper and paperboard used, with printing papers, including newsprint, taking some 30%; five million tons of newsprint are imported annually. About 700,000 tons of purified wood pulp fibers are consumed for rayon and cellophane, and wood fibers are also used for molding sewer pipe, conduits, etc., as fillers for plastics, and in the preparation of photographic film and explosives used as propellants. Chemical by-products of pulping operations, based on lignin, a chemical constituent of wood, find a number of uses in leather tanning, for mud control in oil-well drilling operations, as strengtheners for ceramics, for the dispersion of pigments, carbon black, and other insoluble materials, in compounds for reducing scale formation in boilers, and in the formulation of other industrial chemicals. Vanillin for food flavoring is one of the better-known by-products.

Paper products compete with many other materials, but for some purposes nothing is as satisfactory or as cheap as paper. No other material, for example, offers the advantages of paper

How the thinnest paper in the world helps this giant run



At the very heart of this locomotive's throttle control system is condenser tissue—the thinnest paper known to science. Without it, the engineer's touch would go unheeded. Without it, no messages could be sent or received over the train's communications system. In short, without condenser paper, this giant would stand lifeless.

Wherever you find electronic controls and equipment you find condenser tissue at work—on all types of diesel locomotives, manufacturing control systems, in television, radio, radar.

This thinnest of papers calls for a carefully engineered pulp that meets many unusual requirements—thickness to .0004 of an inch . . . tolerance held down to .00005 of an inch . . . a minimum of pores and pin-holes . . . exceptional chemical purity . . . long-life and durability.

Coming up with the *right* pulps for special papers like condenser tissue is a job our Technical Service Division has been performing for more than half a century. If you have a paper problem, perhaps we can help you, too. Write to Dept. **PD-10** in our Boston office.

BROWN QUALITY COMPANY, Berlin, New Hampshire
CORPORATION, La Tuque, Quebec

General Sales Offices:
150 Causeway Street, Boston 14, Mass. • Dominion Square Bldg., Montreal, Quebec

SOLKA & CELLATE PULPS • SOLKA-FLOC • NIBROC PAPERS • NIBROC TOWELS • NIBROC KOWTOWLS
NIBROC TOILET TISSUE • BERMICO SEWER PIPE, CONDUIT & CORES • ONCO INSOLES • CHEMICALS

for printing. In fact, printing papers, including newsprint, have probably reached maturity, because of increased use of radio and television for communication of ideas and advertising, and markets for printing papers may grow more in line with population increase. New methods of treating paper with resins or plastics, however, have greatly increased the use of "utility papers"—wrappings, toweling, tissue, and the like. Here, price is a distinct advantage, since other materials with suitable properties are considerably more expensive. Waxed paper, for example, costs about 1.5 cents for 1000 sq. in.; other representative prices are: glassine, 2.1 cents; cellophane, 3.3 cents; polyethylene film, 3.8 cents, and Pliofilm, 4.7 cents. The trend to prepackaging, especially of foods, offers great promise for further growth of this portion of the industry. Multiwall paper bags are gaining ground for packaging cement, fertilizers, bulk chemicals, animal feeds, and similar products.

Paperboard and building board are in the fastest growing segment of the industry, and great progress has been made in developing new uses. The growth of frozen foods is an important factor in greater paperboard consumption. Paper milk containers also have been well received; over seven billion were produced in 1951. Construction panels of hardboard separated by corrugated paper also appear promising.

Continued growth in paper and paperboard will mean larger supplies of wastepaper, which are an important contribution to the raw-materials situation, although waste is not directly competitive with virgin wood pulp for many applications. Pulp-producing and waste-collection facilities on the North American continent are sufficient to supply all projected production capacity. One great advantage is that wood is a renewable resource, and proper management of forest reserves assures a steady supply. The amounts of timber grown and wood removed are approximately balanced now, and growth in properly cut forests is at a higher rate than in virgin forests. When woodlots are properly maintained, losses from insects and fire are greatly reduced; fire loss in some areas may be as low as one quarter of one per cent.

Product lines of pulp and paper companies are now being arranged to take advantage of the differing rates of growth of the various wood species available. Rotation may be in a cycle of anywhere from 25 years for Southern softwoods to 100 years for the forests on the West Coast. New pulping processes for woods previously considered low-grade have opened new sources of raw materials without necessitating the acquisition of greater tracts of woodland. Fibers from hardwood are shorter than those from typical soft pulpwoods, and are useful in plastics manufacture and in obtaining a hard paper finish. Considerable emphasis is now being placed on lignin utilization, since the lignin content of some hardwood logs ranges from about 20 to as much as 40%. By use of recently developed methods, it is now possible to make pulp containing most of the cellulose components of the wood and a varying quantity of lignin. The start which the industry has made toward utilization of the present "waste" fraction of wood should lead to interesting developments, with particular emphasis on increased pulp yield.—*Industrial Bulletin.*

Asbestos

Simple, effective procedures for reclaiming asbestos from discarded pipe insulation have been developed by E. W. Zimmerman of the National Bureau of Standards. Extraneous material is removed from the asbestos cloth by chemical treatment, and the cleaned cloth is reduced to fiber form in a paper-pulp beater. The recovered asbestos is unchanged chemically, with little or no shortening of the fibers. It appears well suited to further use as electrical and heat insulation for making asbestos paper, and as a filler in molded plastic compounds.

Because of its incombustibility, strength, and low conductivity, asbestos is widely used in roofing shingles, fireproof paints, stove and building insulation, heat-resistant aprons and gloves, and brake linings. However, present supplies of this raw material are critically short. As large quantities of molded asbestos and asbestos cloth are used to insulate pipes of various kinds in naval vessels, the Navy Bureau of Ships requested NBS to study the possibilities of reclaiming asbestos insulation discarded during the repair or refitting of ships.

To aid the Bureau in its investigation, the Navy supplied samples of discarded pipe insulation. These were of three general types: asbestos cloth, asbestos-cotton cloth, and a molded pipe lagging having asbestos fiber as a filler and magnesia cement as a binder. Some of the asbestos-cotton cloth had glass strands woven into the yarns. Other samples of this cloth were painted or were covered with a cementlike material containing magnesia. The problem thus reduced itself to two parts: first, removing the extraneous material and, second, reducing the cleaned yarns or cloth to fibrous form.

For applications where flexibility is desired, such as asbestos paper or cloth chrysotile asbestos is used. Although this type of asbestos is quite satisfactory for insulating heated pipes, it loses its water of constitution and becomes brittle when heated to about 800°C. It was therefore necessary to develop procedures that would reclaim the asbestos fibers without the use of excessively high temperatures.

It was found that asbestos or asbestos-cotton fabrics other than those containing paint can be freed of adhering cement by first treating with 5% hydrochloric acid and then rinsing. Fabrics painted on one side are treated with alkali instead of acid to remove the paint as well as the cement. This is accomplished by boiling in 5% sodium hydroxide solution for 15 to 30 min., followed by a preliminary rinsing, a warm wash with a synthetic detergent to remove the paint pigments, and a final thorough rinsing.

Removal of cotton from the cleaned cloth is best effected by the use of heat, but the process requires rather careful control to avoid loss of the water of constitution and consequent embrittling. Thin layers of the material are heated in a muffle furnace at a temperature between 400 and 450°C. The time necessary to burn out the cotton in this temperature range depends largely on the equipment used. After removal of cement, paint, and dirt, the cloth is reduced to fiber in a rotary food blender or in a paper pulp beater.

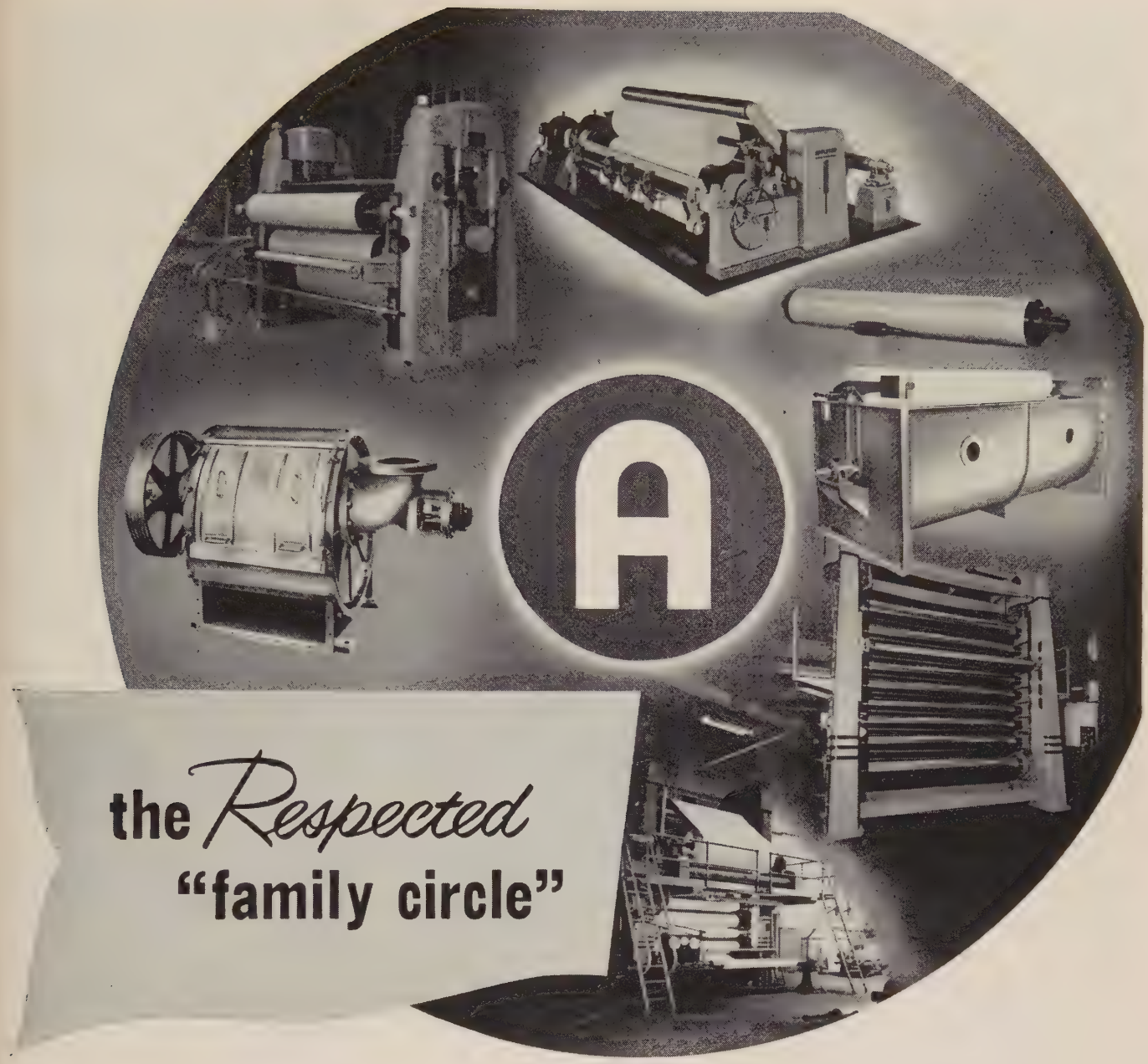
The fabric containing glass strands was composed of very short asbestos fibers. While an acid wash followed by rinsing removes most of the cement from this material, removal of the dirt is difficult without loss of some of the short asbestos fibers, which float off with the dirt. The recovered product contains glass fibers intermixed with the short asbestos fibers and thus will probably be of limited use.

The molded insulation yielded only 15% of fiber, and this was highly contaminated with foreign materials. Thus, recovery of asbestos from such material does not seem very practicable. In any case, use of the fibers recovered from the molded insulation would have to be limited to magnesia-cement components and similar products.

The Parchment Process

The grease-resistant, high wet-strength material formed by the modification of a sheet of special paper by means of sulphuric acid is called vegetable parchment. It was invented approximately 100 years ago and was called parchment because it closely resembled the parchment made from hides of animals. The invention around 1850 by an English chemist, W. E. Gaine, is said to have been made when he accidentally dropped a rag paper into sulphuric acid and quickly washed it with water.

Manufacture of this new paper in the United States started in 1885. The name vegetable parchment is used to indicate its manufacture from vegetable fibers.



...of pulp, paper and textile mill equipment. For 70 years Appleton Machines have been custom-built to standards that have *earned* the respect of the industry.

APPLETON MACHINE COMPANY
APPLETON WISCONSIN

CUSTOM-BUILDERS OF PULP & PAPER MACHINES · WINDERS · FINISHING ROLLS · REWINDERS

Today, by far the largest use for vegetable parchment is in the packaging of food products. It is most familiar to everyone as the wrapper around butter or oleomargarine which comes directly in contact with the greasy product.

In the food industry, genuine vegetable parchment is the ideal material for the packaging of butter, lard, vegetable shortening, oleomargarine, fresh, frozen and treated meats, fish, poultry, cheese, ice cream, and other similar moist or greasy products. For canned meats and fish, parchment is used as a liner to prevent discoloration and contamination of the food. It is also used for milk bottle hoods and as label sheets for bulk ice cream.

Meat markets use parchment as a "slap sheet" or as an interleaving sheet between slices of liver. They also use it to wrap poultry giblets for placement inside the cavity of the bird.

Parchment is widely used in the vegetable markets to wrap or band celery, broccoli, onions, and other fresh produce.

Industrial uses for parchment are found in the wool industry in the spinning process, in the rubber industry as an interleaving sheet, and in the steel industry as metal parts wraps.

It is also widely used in the food industry in box liners for greasy products such as doughnuts and cookies, printed inserts in ready-mixed cake packages and coffee cans, cheese wrappers, and tamale and corn-on-the-cob wrappers. Parchment is popular as a tracing paper, greeting card material, and as a base stock in the duplicating field (Ozalid).

A study of these uses indicates that vegetable parchment has many curious properties in comparison with ordinary paper. It is grease-resistant in lighter basis weights and greaseproof in heavier basis weights. It will not disintegrate in water. (This is true even when it is boiled for hours.) It has high wet strength. It is completely odorless and tasteless. In the lighter basis weights, parchment allows air passage (important in wrapping fresh vegetables) between wrapper and product.

While the color of parchment is usually white, it can be made in a variety of colors.

Vegetable parchment is free of loose fibers and therefore is useful where lint is a problem. It is impervious to many chemicals and useful as a dialyzing membrane.

Vegetable parchment is normally produced in standard basis weights of 27, 35, and 45 lb. Special grades for special uses are made in a variety of weights varying from 18 to 120 lb. An example of these tailor-made orders is the 70-lb. sheet used for packing shortening in corrugated containers. Besides being greaseproof, it must be pliable enough to form a bag for the corrugated box and withstand handling in shipment without rupture.

The base stock for vegetable parchment is called waterleaf. This paper is made from specially selected sulphite or sulphate wood fiber. It is extremely absorbent to water and solutions because it is unsized.

A parchmentizing machine consists of four major sections: the acid dip, the acid recovery system, the washer section, and the drier section. The machine treats a continuous web of waterleaf with sulphuric acid and washes and dries finished parchment. Parchment machines are made with such an efficient closed system that the make-up sulphuric acid requirements are very small.

After leaving the last press of the washer section, the paper is led over conventional paper machine driers and wound up on a reel. Special sizings, such as starch, glycerine, sodium benzoate, and sodium propionate are applied to the sheet by means of an ordinary size tub. These sizings can give it mold-inhibiting, anti-rancidity, anti-oil creep properties, as well as releasing qualities toward crude rubber and adhesive masses. Regular vegetable parchment is wound up on the reel as a pure cellulose web.

The basic crew on a machine consists of washerman and drierman. Although the maximum web width on machines is 100 in., lesser sizes can be obtained by inserting a shorter waterleaf roll or trimming. Because the final product cannot be reworked it is desirable to trim before parchmentizing. Waste parchment is either burned or shredded as excelsior and used for packing material.

Parchment is waxed when resistance to moisture vapor is desired and the waxed sheet is used principally for fish wrappers and sausage bags. For butter wrappers the parchment is semiparchmentized and lightly waxed, resulting in a measure of water resistance and enough workability for butter-wrapping machines. Strong creped parchment is ideally suited for barrel lining and heading when wet and greasy materials are being packed.

Opaque parchments are made by adding titanium filler to the beaters, enhancing the appearance of the parchment. Semibleached kraft is used in producing a brown-colored parchment with increased burst and tear properties.

All printing methods are used in the printing of parchment but letterpress is perhaps the one most widely used. Both metal and rubber plates can be employed.

Ink suppliers have done an excellent job in perfecting inks which will print on parchment and still pass rigorous laboratory and use tests. Printed oleo and butter wrappers, for instance, are made to withstand soaking for days in salt water and other solutions. In none of these should the ink rub off, change color, or cause discoloration (bleed).

The manufacture of vegetable parchment represents a very small section of the total paper and paperboard industry. It is small in comparison because for the majority of uses of paper there is little need for grease-resistance or wet strength or a combination of these two properties. Then, too, the added conversion makes these papers cost more than ordinary sheets. This industry, however, fills a very definite need in the paper field.

Chicago Quartermaster

In a move to expand research resources, the statistical services of the Quartermaster Food and Container Institute for the Armed Forces, Chicago, have been incorporated into the Office of the Scientific Director, Donald K. Tressler, scientific director of the Institute, announced. Kenneth R. Wood has been named chief of the newly formed Statistical Design and Analysis Office.

Modern mathematical approaches to experimental work vastly increase the efficiency and economy of investigations. The Institute move permits joint planning of research among the various divisions of the Institute and ready analysis of research results by statistical methods. The new Statistical Office will advise both food and container experts concerning the statistical planning of all experimental work, interpret the results of such work, and, as time permits, carry out research on experimental test design and methodology.

Svensk Pappers Tidning

The July 31 issue of *Svensk Pappers Tidning*, Stockholm, Sweden, was prepared especially for the Symposium on the Chemistry of Wood and Wood Constituents at the International Congress of Pure and Applied Chemistry. It includes several articles of general interest: "The History of the First Industrially Manufactured Sulphite Pulp," "Some Swedish Contributions to Wood Chemistry," "Characteristic Features of Modern Swedish Cellulose Industry," "Development of Swedish Forest Products Research," "Dissolving Wood Pulps," "Present Tendencies in the Development of Pulp Bleaching," and "The Origin of the Defibrator Process."

Federal Paperboard

Arrangements have been completed by the Federal Paperboard Co., Bogota, N. J., to purchase the National Folding Box Co. of New Haven, Conn.

There's a friendlier atmosphere

—when your plant has a really effective odor abatement program

For many years, the pulp and paper industry has recognized the advantages to be gained by the solution of its air pollution problems. Much time, effort, and money have been expended toward this goal. However, even at the most modern mills, mechanical installations—systems for condensing, scrubbing, and burning the waste gases—have been expensive and have only partially answered the problem. Something more is needed for really effective odor abatement.

Du Pont chemists and engineers had worked closely with management, engineers, and production men at many leading pulp mills on other industry problems, and they teamed up with these men to study waste gas odors. This working together led to the development of specially engineered Du Pont "ALAMASK" odor-masking compounds.

Use of Du Pont "ALAMASK" in actual mill operations has effectively helped to reduce malodors. As a result, these mills are working toward better community relations in a friendlier atmosphere.

Perhaps Du Pont "ALAMASK" odor-masking compounds—together with the experience in pulp and paper industry problems acquired by Du Pont technicians—can help your firm establish a more effective odor abatement program. For information and technical service, write to E. I. du Pont de Nemours & Co. (Inc.), Organic Chemicals Dept., Wilmington 98, Delaware.

Put good will in the air with

Du Pont **Alamask**

REG. U.S. PAT. OFF.

Odor-Masking Compounds

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING

...THROUGH CHEMISTRY

Fischer & Porter

Fischer & Porter Co., Hatboro, Pa., has issued a new 16-page catalog "An Introduction to Flowrator Meters" (10-A-10).

Appleton Woolen

F. H. (Curly) Singletary has been appointed representative of the Appleton Woolen Mills in Arkansas, North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas. He is located at Pine Prairie, La.

Merrimac

The Merrimac Div. of the Monsanto Chemical Co., Everett, Mass., has announced that it has developed a new Mersize of lower foaming properties.

Black-Clawson (Shartle & Dilts)

Howard P. Espenmiller has been appointed to succeed George B. Nicholson as director of the Black-Clawson laboratories at Fulton, N. Y. Mr. Nicholson is now with the National Folding Box Co. in New Haven, Conn.

Hydraulic Machinery

The Hydraulic Machinery Co., Tansley St., Montreal, P. Q., has issued an interesting bulletin describing the Cowan Screen (D-600).

Hercules

The Paper Makers Chemical Dept., Hercules Powder Co., Wilmington, Del., has issued a new booklet describing the role of Paracol wax emulsions for paper sizing. The 16-page booklet contains pertinent data such as types of wax emulsions available and information about their use in internal and surface sizing.

The Cellulose Products Dept., Hercules Powder Co., Wilmington, Del., has issued a complete general booklet on Hercules cellulose acetate. This 30-page booklet contains basic technical information on the properties and uses of cellulose acetate.

The section on uses includes considerable new information about acetate specialty lacquers including starting formulas for clear and pigmented outdoor lacquers, heat-resistant paper lacquer, greaseproof wallpaper lacquer, plastic coatings, and dipping lacquers.

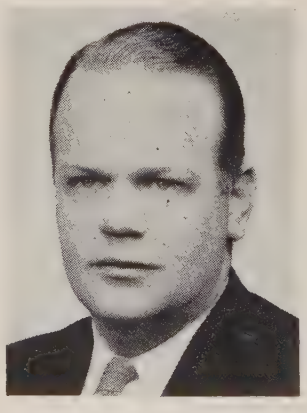
Hooker

J. H. Babcock has been named vice-president of Hooker Electrochemical Co., Niagara Falls, N. Y., and J. H. Bruun has been appointed director of research and development.

Black-Clawson (Shartle & Dilts)

Frank T. Peterson, newly elected vice-president of the Black-Clawson Co., Hamilton, Ohio, has been in South America to make a preliminary survey of the South American paper industry in an effort to establish facilities for the manufacture of Black-Clawson papermaking equipment supplied to that continent.

H. P. Espenmiller, The Black-Clawson Co.



F. T. Peterson, The Black-Clawson Co.

Dow

A new $2,600,000 research center is being built at The Dow Chemical Co.'s Texas Div. in honor of William Reed Veazey, recently retired Dow director and research consultant. The research center, which has been under construction at Freeport, Tex., for more than a year, will be completed in September and it will be formally dedicated to Mr. Veazey at a meeting of the general research committee there in October.

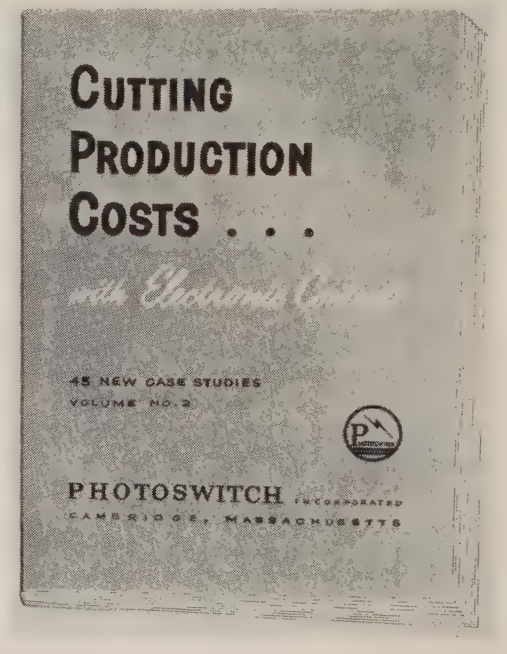
In its 69,000 sq. ft. of space, the research center will house the Texas Div.'s organic, chemical engineering, and electrochemical research as well as the analytical laboratory. It will also include research administrative offices, a patent office, and a library.

A decorative and durable fire-retardant coating for wallboard and sound-absorbing tile has been developed through the use of a plastic latex of the vinyl chloride vinylidene chloride type, by the Dow Chemical Co., Midland, Mich.

Highly resistant to scrubbing and to heat and humidity, the new coating is of the "intumescent" type, which swells up and covers the surface with a protective layer of char when a flame strikes it. It is designed to meet manufacturers' specifications for fire-retardant coatings on insulating wallboard and acoustic tile.

Photoswitch

Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass., has issued a new edition of its book, "Cutting Production Costs with Electronic Controls."



The 46 new case studies explain how standard packaged electronic controls have solved many problems of weighing, counting, measuring, timing, and cycling, therby achieving new efficiency through the use of electronic controls for all types of industrial applications.

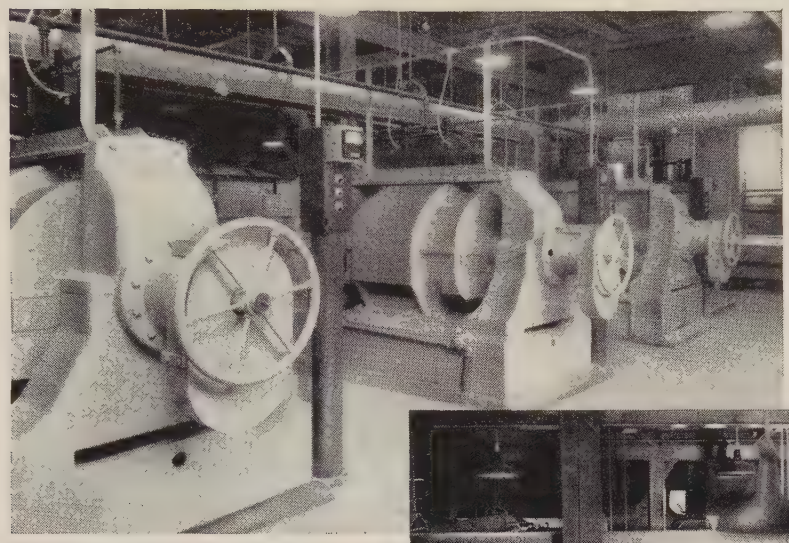
Industrial Nucleonics

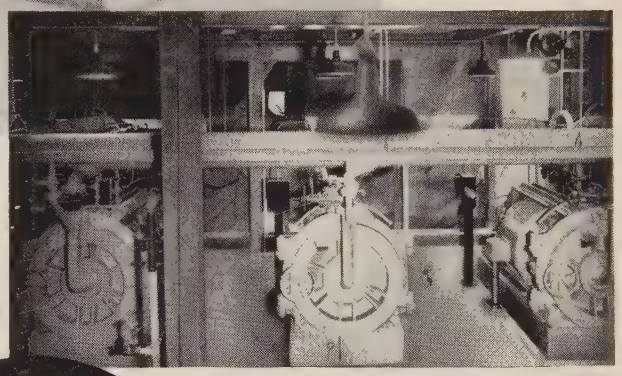
A new basic mounting design for AccuRay radiation gages has been announced by Industrial Nucleonics Corp. of Columbus, Ohio. Featuring a streamlined measuring head and a tapered bracket, the new unit permits a standardization

for economical HIGH YIELD KRAFT pulping—

WEYERHAEUSER TIMBER CO.
PULP DIVISION USES

Sprout-Waldron Refiners





THE FIRST HIGH YIELD KRAFT PULP MILL ON THE PACIFIC COAST

uses three Sprout-Waldron 450 h.p. 36-2 Refiners for Hot Brown Stock Refining

The SPROUT-WALDRON refiner is the leading producer of high yield pulps

high capacity

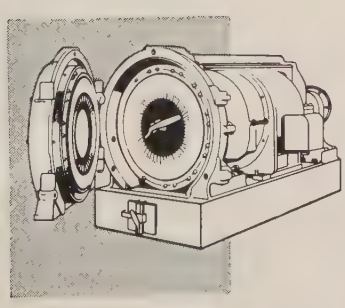
flexibility of operation

high pulp quality

rugged construction

Does High Yield Kraft Pulping fit into your plans?
Send for Bulletin 92—"High Yield Kraft Pulping—a Process Study".
Sprout-Waldron & Co., Inc., 38 Logan Street, Muncy, Pennsylvania.

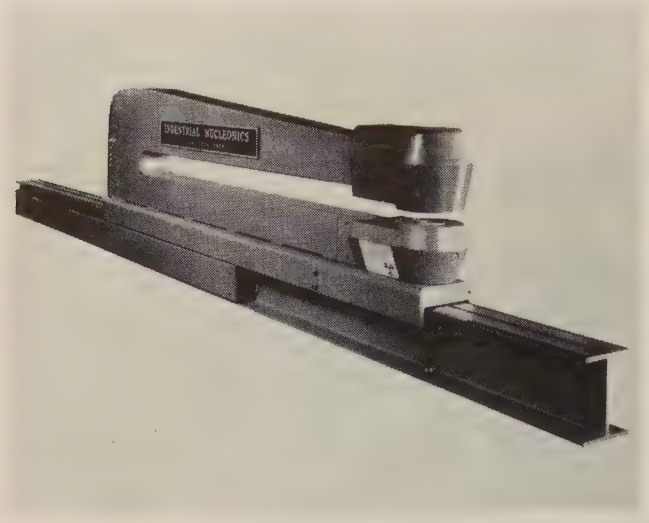
S W



SPROUT-WALDRON

PULP REFINERS

of measuring systems throughout the complete line of Accu-Ray mountings. The tapered bracket, available in throat depths up to 160 in., is said to be extremely strong and resistant to vibration and shock.



The new basic mounting design for AccuRay radiation gages

Of special interest to industries where sheet profile control is important is the new variable-speed scanning mechanism also announced by Industrial Nucleonics. This unit enables the gage to move slowly across sheet while presenting a continuous profile picture, and then retract quickly to repeat the scanning cycle. When the gage withdraws, the recorder pen remains stationary to mark the beginning and end of each profile reading.

Koppers

Appointment of Clinton H. Johnson as sales engineer in the Electrostatic Precipitator Dept. of Koppers Co., Inc., Pittsburgh, Pa., was announced by J. L. Tunstead, general sales manager of the company's Metal Products Div.

Chemical Linings

Chemical Linings, Inc., of Watertown, N. Y., has initiated a retirement pension plan for all of its employees, effective June 1, 1953. The plan provides for retirement at age 65 with benefits based on average earnings and years of service. This is in addition to the group life and hospitalization insurance which has been available to Chemical Linings employees for some time. Underwritten by the Aetna Life Insurance Co., the plan also provides substantial death benefits to dependents of employees both on active or retired status. Participation is voluntary, and the employee contributes a small fraction of the cost of the plan.

Butterworth

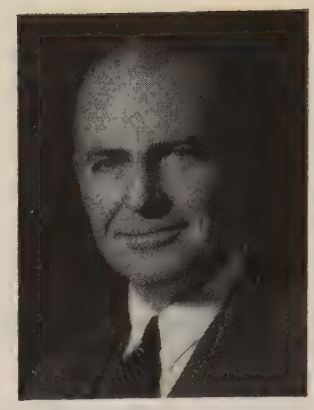
J. Ebert Butterworth, president and chairman of the board of H. W. Butterworth & Sons Co., textile machinery manufacturers, has announced several changes in management responsibility.

Edward S. Pierce, formerly works manager, has been made general manager in charge of engineering, manufacturing, research and development, purchasing, and personnel.

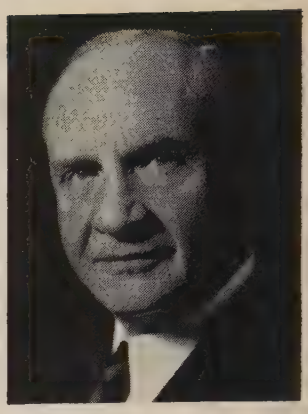
George Bromley, formerly shop superintendent, is now works manager in charge of manufacturing, inspection, production, tools, and methods.

Dorr

John V. N. Dorr, founder and chairman of the board of the Dorr Co., Engineers, has announced that, at a recent meeting



J. D. Hitch, Jr., Dorr Co.



E. R. Ramsay, Dorr Co.

of the Board of Directors, J. Delano Hitch, Jr., presently executive vice-president, was elected president, effective Sept. 1, 1953. On that date E. R. Ramsey, currently president, having reached 65 years of age, retired in accordance with company policy.

Baltimore and Ohio

Howard E. Simpson, executive vice-president of the Baltimore and Ohio Railroad, was elected president at the August meeting of the Board of Directors. Mr. Simpson will succeed Colonel Roy B. White, who has been president of the B. & O. since June 1, 1941, and is now chairman of the board.

General Aniline and Dyestuff

Effective Sept. 8, 1953, the general purchasing headquarters of General Aniline Works Div. and General Dyestuff Corp. will be located at Linden, N. J.

Waldron

John Waldron Corp., New Brunswick, N. J., has published a bulletin (1005) covering its line of extrusion laminating equipment.

Brady

W. H. Brady Co., manufacturers of self-sticking industrial products, has moved its office and plant, and is now located at 727 W. Glendale Ave., Milwaukee 12, Wis.

De Laval

De Laval Steam Turbine Co., Trenton, N. J., announces the appointment of Arthur L. Foltz, Jr., as manager of the Detroit District Office. In his new post, Mr. Foltz is in charge of sales and application in this territory of centrifugal pumps, steam turbines, centrifugal blowers, and compressors.

Huber

Robert B. Takewell, vice-president in charge of the Carbon Black Div., J. M. Huber Corp., New York, N. Y., has been appointed executive vice-president of the corporation, and A. Z. Hahn has been named vice-president of the Carbon Black Div.

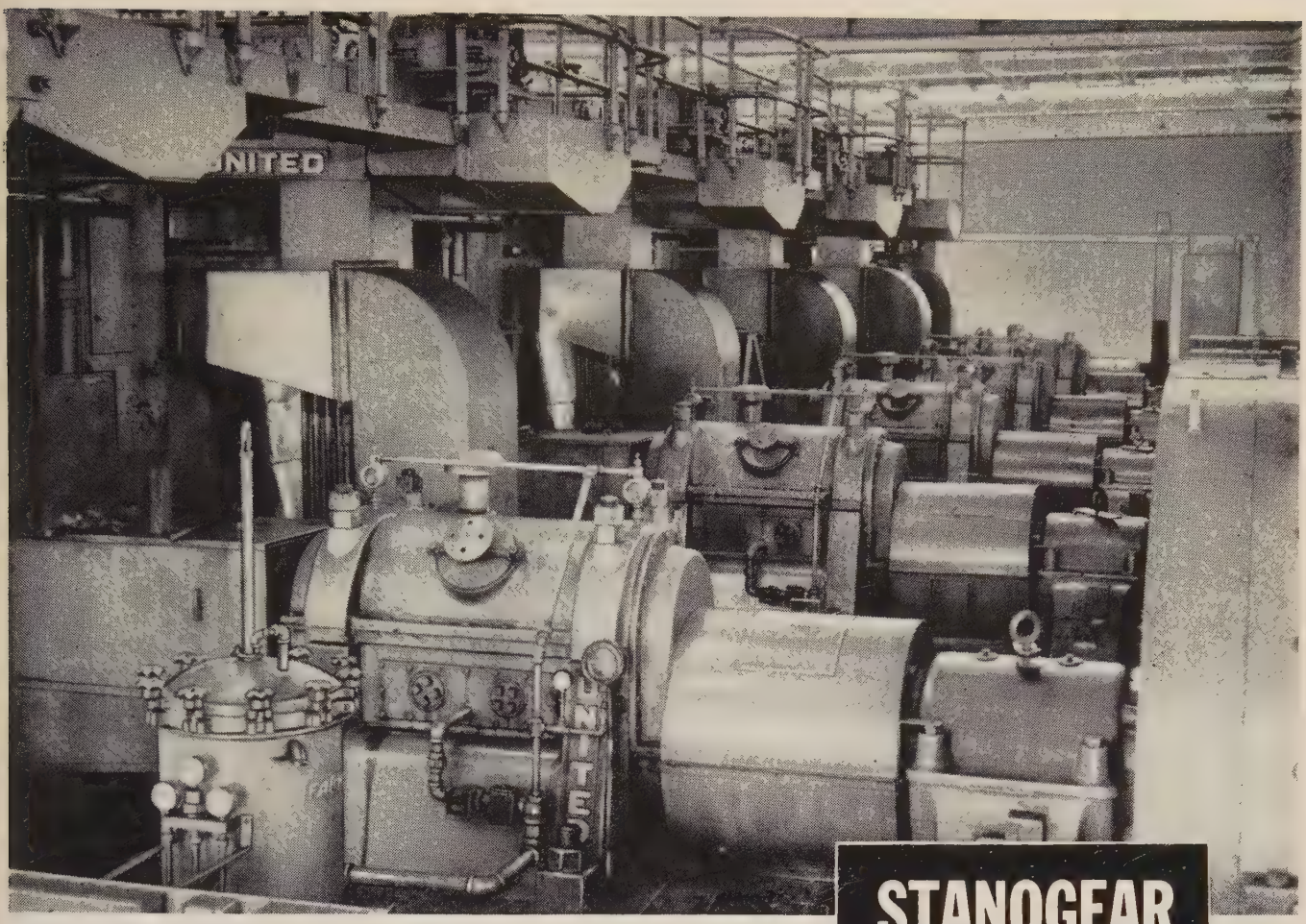
American Cyanamid

Clem W. Kohlman has been appointed advertising manager of the Industrial Chemicals Div. of American Cyanamid Co.

A. M. Asherman will be assistant advertising manager of the Division.

Raybestos-Manhattan

J. H. Matthews has been appointed executive vice-president of Raybestos-Manhattan, Inc. Mr. Matthews started with The Manhattan Rubber Mfg. Co. in 1914.



STANOGEAR
REG. U. S. PAT. OFF.
Compounds

7 ways better for extreme-pressure lubrication...

STANOGEAR Compounds meet the requirements of tougher extreme-pressure lubricating jobs found throughout industry, today. The result of several years of special research and field test work, these outstanding products have proved in actual service their ability to provide these important advantages:

1. Higher load carrying capacity. Use of improved extreme-pressure additives in STANOGEAR Compounds provide a greater anti-weld property. This results in the higher load carrying capacity which these products have demonstrated in actual service.

2. Superior retention of load carrying capacity. In service tests, STANOGEAR Compounds have proved superior to conventional extreme-pressure lubricants in ability to maintain a high load carrying capacity over extended periods of service.

3. Freedom from objectionable deposits. Appropriate base stocks and additives give STANOGEAR Compounds a high resistance to oxidation, thus minimize the formation of deposits.

4. Excellent storage stability. STANOGEAR Compounds contain compounding ingredients which assure excellent stability both in service and storage.

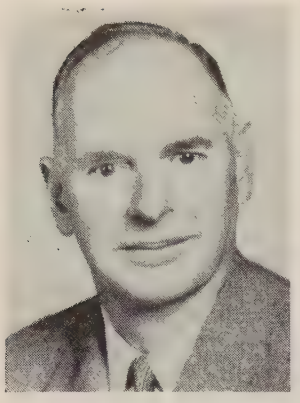
5. Good water separation. STANOGEAR Compounds have demonstrated their superiority to ordinary extreme-pressure lubricants in ability to provide good water separation.

6. Anti-foaming. Under adverse operating conditions, the anti-foam agent in STANOGEAR Compounds has prevented foaming troubles.

7. Versatility. A unique combination of additives in STANOGEAR Compounds equips these products for various industrial gear applications where extreme-pressure lubricating properties are necessary. To meet varying viscosity requirements, STANOGEAR Compounds are available in eight viscosity grades.

The Standard lubrication specialist in your area of the Midwest will be glad to give you more information about STANOGEAR Compounds. You need only phone your local Standard Oil office. Or write: Standard Oil Co., 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY STANDARD *(Indiana)*



J. F. Fitzgerald, National Starch Products, Inc.

NATIONAL STARCH

J. F. Fitzgerald has been elected an assistant vice-president of National Starch Products, Inc., New York, N. Y. Mr. Fitzgerald has been associated with the company for the past 18 years.

STANDARD (INDIANA)

Standard Oil Co. (Indiana) has adopted a simplified, uniform color scheme for its 55 and 33-gal. drums, namely, a bright blue it hopes the public will identify with its products.

ALLIS-CHALMERS

Construction features of Allis-Chalmers vertical paper stock pump are described in a new bulletin (52B 7839) released by Allis-Chalmers Mfg. Co., 828 S. 70th St., Milwaukee, Wis.

The bulletin points out that the vertical design is inherently better able to handle heavy stock because the material flows into the eye of the impeller by gravity. Air naturally tends to rise out of the stock as it flows downward and gravity increases the suction head just before the stock enters the impeller. Pumping problems are further reduced, it is explained, by the large ratio of suction to discharge opening areas, as high as 28 to 1. The space saving pump is available in seven different sizes and types in capacities to 5500 g.p.m. at heads to 270 ft.

Features of Allis-Chalmers Type H starters built to control squirrel-cage, synchronous, wound rotor, and multispeed motors in ratings from 2200 to 5000 volts are described in a new 12-page bulletin (14B 6410B) released by the company.

MINNEAPOLIS-HONEYWELL

Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Philadelphia 44, Pa., has published a bulletin (1210) covering the Brown portable potentiometers, with direct reading temperature, millivolt, and extended range scales. Wiring diagrams, instructions, specifications, and special features are also included. Honeywell's six-page bulletin, 14-1, describes various ElectroniK instruments.

ALBANY FELT

After 8 months' operation, the plant of the Albany Felt Co. of Canada, Ltd., is now embarking upon its first expansion program. Since 1952, when this modern $2,000,000 plant was built in Cowansville, Que., it has been manufacturing every size of papermaker's felt required by the pulp and paper industry.

The company has recently ordered and is awaiting delivery of a new 600-in. Crompton & Knowles felt loom, the largest ever built for a Canadian mill, a giant custom-built Riggs & Lombard double-sided rotary fulling machine, and other new equipment.

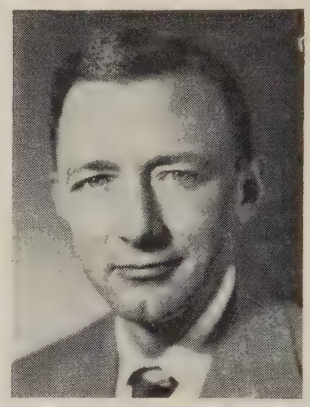
Officers of the Canadian subsidiary include: Lewis R. Parker, chairman of the board; John C. Standish, president; Z. J. Chagnon, executive vice-president; and James G. Reaser, treasurer. The company superintendent is Spencer Standish and his assistant and chief designer is Harold Fabricius.

B. & W.

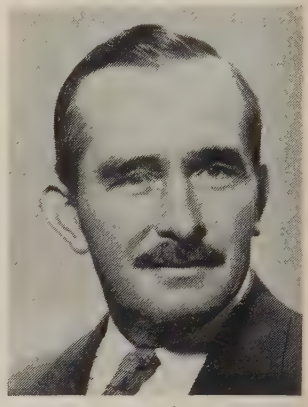
A. B. Capron, formerly chief engineer, has been named assistant works manager in charge of the tube mills and engineering, and Newell Hamilton, formerly superintendent of the steel mill, has been appointed manager of steel operations in the Tubular Products Div. of The Babcock & Wilcox Co., Alliance, Ohio.

IMPCO

Joseph K. Perkins, sales engineer for Improved Machinery, Inc., Nashua, N. H., formerly Impco representative in the middle Atlantic States, has been transferred to the home office in Nashua, N. H. Mr. Perkins started with Impco in 1946 and has been residing in Richmond, Va.



J. K. Perkins, Improved Machinery, Inc.



R. C. Richter, Improved Machinery, Inc.

Recently appointed to represent Impco in the middle Atlantic States is Rudolph C. Richter of St. Marys, Ga. He is now residing in Lynchburg, Va.

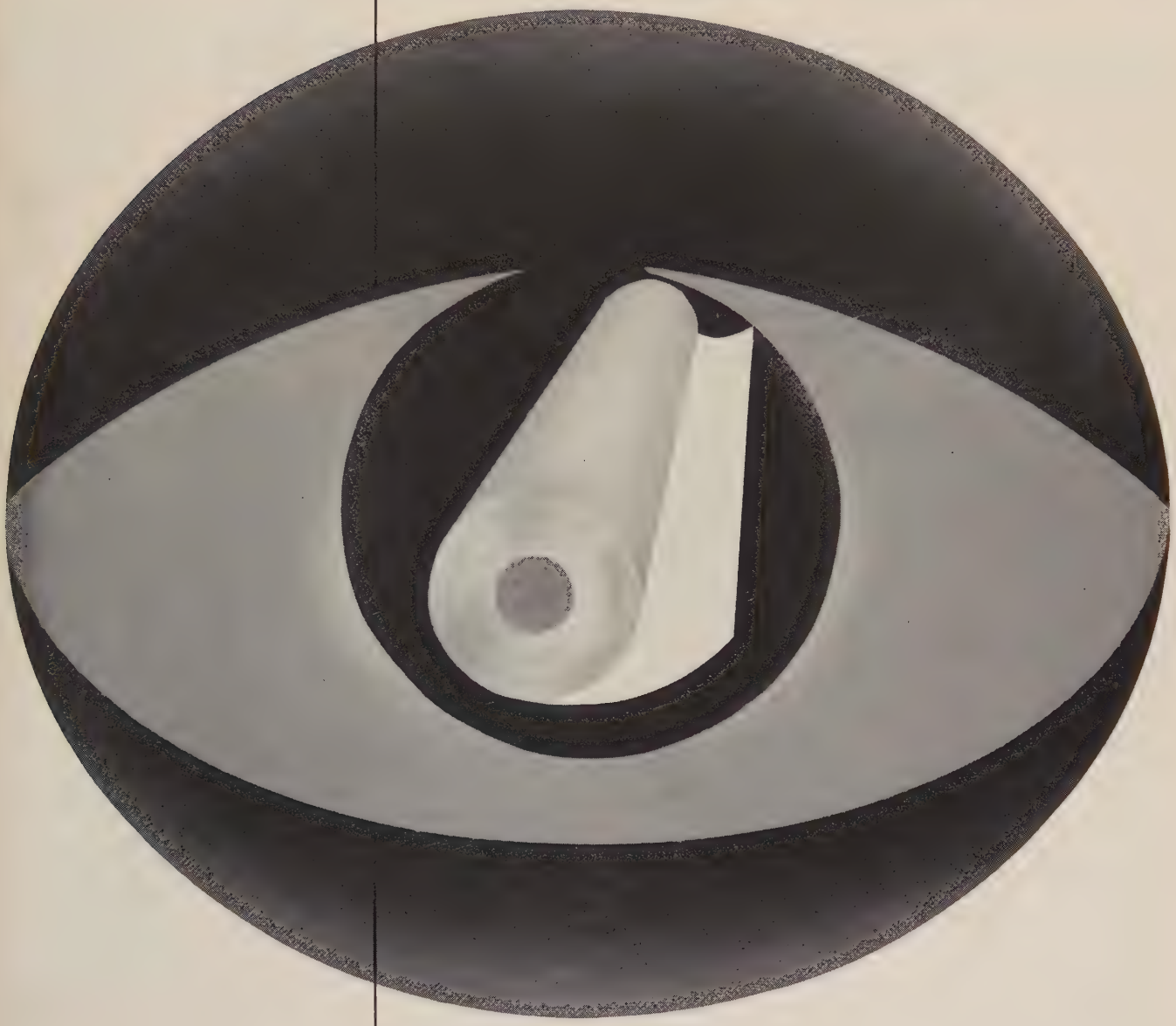
TRACERLAB

A unique paper scanning device incorporating a beta gage has recently been developed by Tracerlab, Inc., 130 High St.,

The Beta Gage Strip Scanner

Appleton Felts

MAKE GOOD PAPER



APPLETON WOOLEN MILLS
APPLETON, WISCONSIN

Boston 10, Mass., for Southland Paper Mills, Inc., Lufkin, Tex. The device is so sensitive that a recorder trace of two successive scannings of the same strip of newsprint can be superimposed.

Instead of scanning across the moving sheet as it is being produced, the Peta Gage Strip Scanner measures a profile of a 220-in. paper strip taken straight across the sheet and provides an easily interpreted measurement of web variations.

Du Pont

Charles T. Locke, a sales representative for the du Pont Co.'s Dyes and Chemicals Div., has established new headquarters in Plymouth, Wis.

Dicalite

Joseph E. Moran, general sales manager, Dicalite Div., Great Lakes Carbon Corp., left New York by plane Aug. 29, 1953, on a European trip which is expected to take him to 16 countries and extend over 3 months. Mr. Moran plans to visit Dicalite agents in England and on the continent and to contact prominent users of Dicalite materials. Another objective of the trip is to survey market potentials for diatomite materials.

Staley

The formation of a wholly owned subsidiary, Staley International, Inc., to handle the sale of its products in the Western Hemisphere outside the U. S., has been announced by the A. E. Staley Mfg. Co. The new corporation, which will have offices in Decatur, Ill., is incorporated in Delaware. Its president is E. M. Bailey, Staley export sales manager since 1927. Other officers, all of them employees of the parent corporation, are V. R. March, vice-president; R. S. Bass, treasurer; Pauline Cable, secretary; Herbert Scholes, assistant secretary and treasurer; E. K. Scheiter and Walter E. Morey, directors.

Hubinger

The Hubinger Co., Keokuk, Iowa, has outgrown its present laboratory and has decided to erect a new laboratory building with modern facilities. Ground has already been broken, and the new laboratory building will be completed sometime after the first of the year. The new laboratory will be set back from Fifth St. to allow angle parking in front. It will be approximately 101 ft. long by 36 ft. wide. There will be three floors with the second floor on the level of Fifth St. The entire building will be of fireproof construction consisting of reinforced concrete and Haydite blocks with a buff brick veneer. Glass block windows and forced air ventilation throughout the building will practically eliminate dust and other things in the air that can affect work being conducted in the laboratory. The second and third floors will be air conditioned.

One half of the first floor will be a pilot plant where scale model converters, driers, a double backer to test corrugated paper pastes, and other machines will be used to conduct experiments and tests with the processing and uses of refined corn products. The other half of the first floor will be storage area for chemicals and equipment. The sample department will headquarter there also.

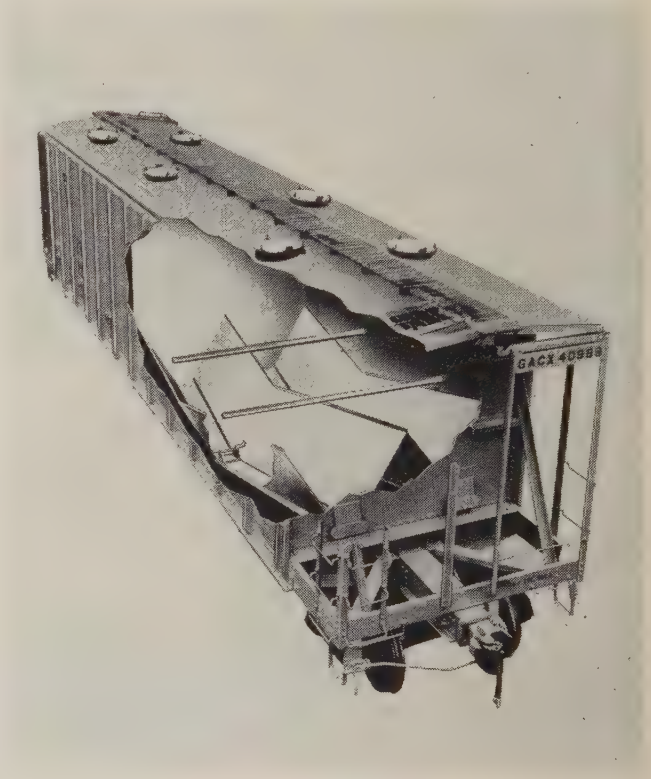
The general control laboratory will be located on the second floor. There will also be a library containing technical and reference books, a qualitative and quantitative laboratory where chemical analyses may be made, a bacteriological laboratory, a laboratory office, and a report room where daily records, charts, etc., may be made.

A conference room will occupy about one half of the third floor of the new laboratory building. It will be used for safety meetings, apprentice training classes, credit union meetings, educational meetings, etc. The engineering department will be located on the third floor too. Plans call for one large drafting room and an office for the plant engineer.

GATX and Fuller

The radically new Airslide car (a specialized covered hopper car for bulk shipping) has created something of a sensation in the few short months it has been in existence. The car, shown recently at Materials Handling and A.A.R. Convention, is built and designed by General American Transportation Corp. of Chicago, Ill., in collaboration with the Fuller Co. of Catasauqua, Pa., and is at present making a nationwide tour.

The Airslide car is especially designed for bulk shipping of dry, powdered, or granular commodities. Airslide cars can be built to handle high or low density materials equally well. The car is loaded by gravity and unloaded in any of three different ways: (1) by gravity feed into hoppers below track; (2) through utilization of any mechanical conveyor system; (3) or through any pneumatic conveyor system—vacuum or pressure.



Cutaway view of the Airslide car

The car has two trenches running the full length of the interior and sloping toward the center. An Airslide fabric is fastened to the underside of each trench. This fabric is chemically treated and totally encased by a U-section of light gage steel. Approximately 1 lb. per sq. in. of air pressure will activate the loading and unload it with fluidlike speed, evenly and thoroughly through outlet valves on the bottom of the car.

The car makes possible substantial savings in dunnage, handling costs, and in overhead. Because of Airslide's unique design, bulk materials are protected against shrinkage and leakage with a minimum possibility of contamination and infestation.

Cameron

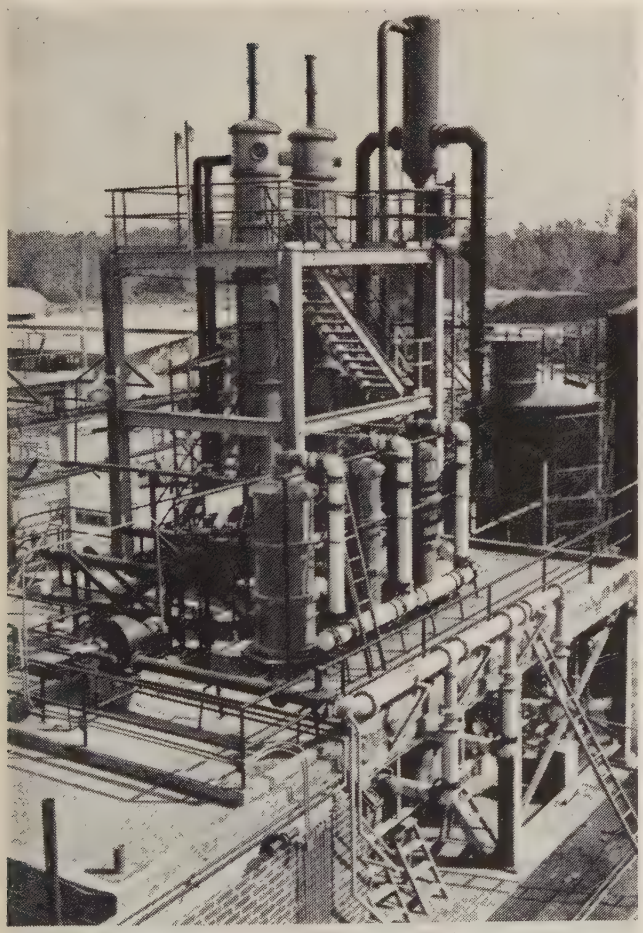
Cameron Machine Co., 61 Poplar St., Brooklyn, N. Y., has recently completed the design and manufacturing of a

NEW!

TWO MORE SOLVAY FIRSTS FOR THE PAPER INDUSTRY!

1 ***A new, practical, safe, low-cost method of producing chlorine dioxide***

2 ***A new, improved method of pulp bleaching with chlorine dioxide***



Chlorine dioxide plant of Riegel Carolina Corp., Acme, North Carolina, showing absorber and reactor towers, steam jet refrigeration unit and sodium chlorate and sulfuric acid tanks.

- ★ **90 G.E. brightness or better with less than 1% chlorine dioxide**
- ★ **Exceptionally low dirt count**
- ★ **Excellent pulp characteristics with no strength loss**
- ★ **Low chemical costs**
- ★ **Reduced pulp shrinkage**

Through Solvay's exclusive new methods employing chlorine dioxide, pulp makers can obtain higher quality, bleached, purified pulp with *finer fibres . . . higher brightness . . . better permanency of color . . . no quality degradation*—AT NO INCREASE IN COST!

Now for the first time Solvay makes available to the industry a *tested, proven method* of producing chlorine dioxide *economically* and *safely* and an improved method of using chlorine dioxide in a bleach sequence.

The efficiency and dependability of the new Solvay methods have been *tested* and *proved* by the continuous production of thousands of tons of superior pulp. The results have exceeded original expectations—results that have not been obtainable heretofore!

Both of Solvay's methods, for which we have applied for patents, are available to the paper industry on a non-exclusive contract on a royalty-free basis.

If you would like to obtain details, we will be glad to send you basic process plans and detailed information. Solvay's Technical Service will be available during design stages as well as during start-up and training periods.

SOLVAY PROCESS DIVISION

ALLIED CHEMICAL & DYE CORPORATION

61 Broadway, New York 6, N. Y.

Allied Chemical

SOLVAY

Soda Ash • Caustic Soda • Potassium Carbonate • Calcium Chloride
Caustic Potash • Cleaning Compounds • Ammonium Bicarbonate
Chlorine • Sodium Nitrite • Sodium Bicarbonate • Snowflake® Crystals
Para-dichlorobenzene • Monochlorobenzene • Ortho-dichlorobenzene
Ammonium Chloride

. . . use ANSUL SO_2 and maintain maximum production

If you must repair or replace your sulfur burner, combustion chamber or gas coolers, use ANSUL liquid SO_2 and keep your mill operating at capacity.

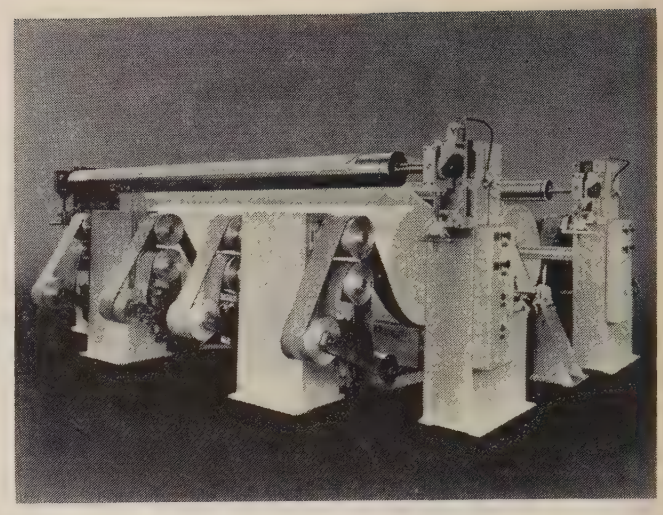
1. Avoid interruption of acid plant operation.
2. Maintain peak capacity in pulp plant during repairs of acid systems.
3. Get proper balance between free and combined SO_2.
4. At a very small installation cost.

Ansul liquid SO_2 may be added simultaneously at one or more points in the system. Prepare for an emergency. Consult the Ansul Technical Staff NOW. Learn how easy and economical it is to avoid shutdown headaches.

Write for file No. 300. You will receive information on how to use Ansul SO_2 to 1) fortify your cooking acid, 2) improve your digester schedules, 3) obtain more complete pulping, 4) get better screening of pulp and, also, 5) for green wood cooks.

ANSUL Chemical Company
INDUSTRIAL CHEMICALS DIVISION • MARINETTE, WISCONSIN

MANUFACTURERS OF INDUSTRIAL CHEMICALS, FINE CHEMICALS, REFRIGERANTS, REFRIGERATION PRODUCTS AND DRY CHEMICAL FIRE EXTINGUISHING EQUIPMENT.



The new Cameron double surface-unwind stand

double surface-unwind stand for use in conjunction with the processing of tissue and other lightweight papers. The first of these new units will be installed at the Scott Paper Co., Chester, Pa.

The double surface-unwind stand was designed and built to provide optimum control for lightweight webs. It unwinds two mill rolls up to 60 in. in diameter and 170 in. wide and combines them into two-ply web at speeds up to 3500 f.p.m. The mill rolls are driven by surface contact with rubber-impregnated, endless woven belts. These belts are under tension, regulated pneumatically, and assure positive pay-off of the webs even with out-of-round mill rolls. Variable tension control, from 0 tension upward is accomplished by cone pulleys through the adjustable belt drive.

Compensating rolls, to overcome "baggy ends," can be vertically adjusted to absorb up to 8 in. in misalignment of the web. Further correction in web alignment can be accomplished through the reel bar bearings, which are equipped for both longitudinal and lateral adjustment. They can be moved 3 in. left and right of center and a maximum of 6 in. from side to side.

In addition to providing unwind control for lightweight papers, the new surface-unwind stand was designed for ease of operation, adjustment, and maintenance. All functions of the unwind stand are centrally controlled. The reel bar bearing latches are opened and closed pneumatically. At the end of a run, the empty reel bars are automatically ejected, quickly readying the unwind stand for the next set. If single-ply tissue is being run, the back section of the unit can be disengaged by a pneumatic clutch.

Magnus

Magnus Chemical Co., Garwood, N. J., announces the application of its Kling oil for reducing time required for hand oiling. Kling oil is a No. 30 SAE oil with the added property of tackiness, so that the oil clings to the bearing surface, does not drip or splatter, and maintains lubricity for much longer periods. In a typical case, oiling frequency was reduced from once hourly to once daily.

National Aniline

John Boykin has been named manager of the Atlanta, Ga., branch of the National Aniline Div. of the Allied Chemical & Dye Corp., 1216 Spring St., N. W. The new branch includes a fully staffed applications laboratory. Local warehouse stocks are also maintained.

Rodney Hunt

A new low-cost, low-maintenance work-positioner, especially suited for bench level presentation of heavy sheet stock such as paperboard, alloy sheet metals, etc., as well as other work-pieces that can be handled in stacks, has been developed

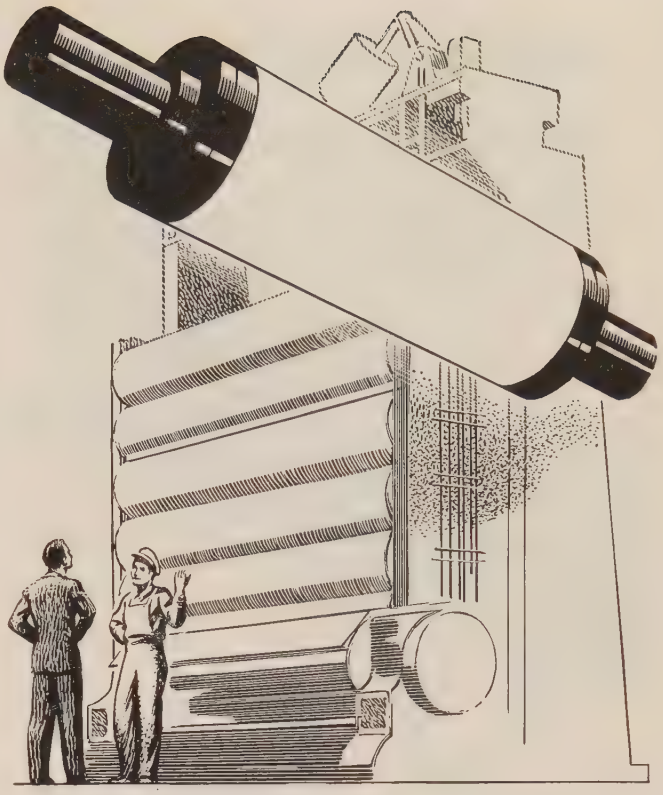
A battery of 11 Bench-evators at the Parsons Paper Co.

by the Special Products Div. of Rodney Hunt Machine Co., Orange, Mass. Called the "Bench-evator," the new bench stand table lift can easily handle loads up to 5000 lb., yet costs only about half the price of other types of work-positioners designed for similar purposes.

The new unit is basically simple, consisting of a self-locking screw-stem hoist set in the floor beside the machine or inspection bench, with a table top that can be made any desired size to handle a customer's particular kind of work. The "Bench-evator" may be installed either as a single unit or a pair of them may be installed one on either side of a machine or inspection bench, one to handle inbound material and the other to receive finished work or accepted sheets. In any case, the table top of the lift is raised or lowered as the work proceeds. This keeps the level of the top of the stack at a convenient height for the machine operator or inspector to take off the top piece, process or inspect it, and place it on the stack of finished pieces.

Raising or lowering the table is controlled through individual push buttons. These can be located at any convenient place on the bench or machine within easy reach of the

Stacks of paper for inspection are kept at a convenient height by adjusting the Bench-evator



For Longer Service— Smoother Surface

You gain two ways when you standardize on Butterworth Calender Rolls — longer service life for lower costs, smoother uniform finishes for a top quality sheet. Prove it in your own mill. Place one Butterworth Roll in a stack. Time it. Note the extra hours you get before turning down or refilling. And compare the difference in the calendering.

Each Butterworth Calender Roll is made to specification, and locked on the shaft under terrific pressure. It cannot slip or come loose. Taper wedges hold forged steel head and shaft rigidly together.

Butterworth Calender Rolls are furnished new or refilled for every calendering need — coated, super, glassine, embossing. Let us quote on your requirements.

For full information, write or call H. W. Butterworth & Sons Company, Bethayres, Pennsylvania – 187 Westminster Street, Providence, R. I. : : 1211 Johnston Building, Charlotte, N. C.

Butterworth
CALENDER ROLLS

make your cylinder mold cleaning

a one-man job

One man can do a more thorough job in less than two hours, than a whole crew can do by using hand methods! The answer is Magnus Pitchex. Let us show you—with Magnus Pitchex—how you can keep cylinder molds at top notch efficiency all the time without wasting man-hours.

magnus

MAGNUS CHEMICAL CO., INC.
104 South Avenue, Garwood, N. J.
In Canada—Magnus Chemicals, Ltd., Montreal
Service Representatives in Principal Cities

inspector or operator. The buttons actuate a 3/4 or 1-hp. electric motor which moves the screw-stem hoist through a worm-gear drive. Automatic limit switches prevent overrunning; usual lifting or lowering speed is 28 in. per minute.

Parsons Paper Co., Holyoke, Mass., reports a saving of 20% in inspection time after installation of a large battery of these Rodney Hunt table lifts. Each of the women inspectors has two of these lifts at her inspection bench; from the stack at her right she removes the top sheet, inspects it on both sides, and places the accepted sheets on the table at her left. She repositions the two lifts (which operate independently) to bring the two stacks back to bench level at about every 5 or 6 in. of change in height of the piles.

With the new lifts, each women inspector can now handle skids with 1200-lb. stacks of paper at one time, instead of the 200-lb. maximum load that was formerly the limit. Much larger sheets—up to 48 by 56 in.—can now be handled than ever before. And since she needs never leave her workplace, does not have to do any lifting, and always has her work at a comfortable bench-top level, inspection goes more rapidly, with very little fatigue.

The equipment also saves labor on handling material to and from the inspection benches. Where formerly three men were required to keep the inspectors supplied with work and to take away the stacks of accepted sheets, now one man can handle this job alone, with no work stoppages while the inspectors are waiting for material. The top of the table lift is designed to be lowered flush with the floor so that a lift truck can easily deliver and pick up the skid pallets on which the sheets are stacked. Because of the relatively simple mechanical principle involved, the "Bench-evator" requires little or no maintenance.

STEBBINS

In August the Stebbins Engineering and Manufacturing Co., Watertown, N. Y., celebrated its 50th corporate anniversary. Founded in 1884 by H. W. Stebbins, and incorporated in 1903, the company has specialized exclusively in the design, installation, maintenance, and repair of corrosion-resistant linings and process vessels.

Present at the incorporation of the University of Maine Pulp and Paper Foundation were, standing, left to right: H. W. Fales, St. Croix Paper Co.; Clifford Patch, Eastern Corp.; C. G. Paine, Eastern Corp.; A. S. Campbell, U. of M.; J. B. Calkin, Consulting Engineer; P. S. Bolton, Robert Gair Co.; W. E. Parsons, Keyes Fibre Co.; W. H. Chisholm, Oxford Paper Co.; L. S. Hatch, Penobscot Chemical Fibre Co. Seated, left to right: T. F. Spear, Oxford Paper Co.; J. L. Ober, Scott Paper Co.; M. C. McDonald, Great Northern Paper Co.; F. A. Soderberg, F. C. Huyck & Sons; T. G. Mangan, International Paper Co.; R. A. Wilkins, Bird & Sons; L. C. Jenness, U. of M.; Pres. Arthur A. Hauck, U. of M.; G. D. Bearce, St. Regis Paper Co.; Harold Holden, Eastern Corp.

While the company serves all process industries, it has devoted its major effort to the pulp and paper industry and has gained wide acceptance in this field. Beginning with the installation of ceramic linings in digesters and acid towers in the sulphite industry, Stebbins has been the leader in the development and application of new lining materials and techniques to satisfy the changing cooking, bleaching, and storage problems of pulp and paper producers. A large majority of the pulp mills in North America use Stebbins lined or Stebbins built vessels.

Today, Stebbins design engineers and construction crews utilize a complete range of materials, such as acid brick, tile, and carbon brick, as well as such membranes as Saran rubber and Tygon, to meet practically any combination of chemical and mechanical requirements.

The main office and research laboratory are located at Watertown. The Pacific Coast is served by the Stebbins Engineering Corp., Seattle, and Canada is served by Canadian Stebbins Engineering & Mfg. Co., Ltd., Montreal.

LETTERS TO THE EDITOR

Cable Report

To the Editor, *Tappi:*

In the August issue of *Tappi* (*Tappi* 36, No. 8: 161A–163A) "Electric Wire and Cable Recommendations for the Pulp and Paper Industry," by A. O. Mortenson, there appears to be an omission which may cause some misunderstanding on the part of the reader.

This relates to Tables II, III, and IV. Actually, Table II is one method of presentation and Tables III and IV together are another approach of presentation. In other words, Table II and Tables III and IV contain the same information but are alternate methods of presentation.

W. C. Bloomquist, *Secretary*
TAPPI Engineering Div.
General Electric Co.
Schenectady, N. Y.

Ed. Note: The above letter was referred to Mr. Mortenson who agreed with Mr. Bloomquist and requested that a revision of part of the report be printed in this issue of *Tappi.* However, since the report will be discussed at the Engineering Conference to be held in Montreal, it is felt that Mr. Bloomquist's letter will clarify the report for the present. Following the conference the information contained in the report will be presented in some other form, possibly as TAPPI Data Sheets or as a recommended practice.

U. S. Patents (First Quarter)

To the Editor, *Tappi:*

In the August issue of *Tappi,* under "United States Patents on Papermaking, First Quarter, 1953" please make the following correction:

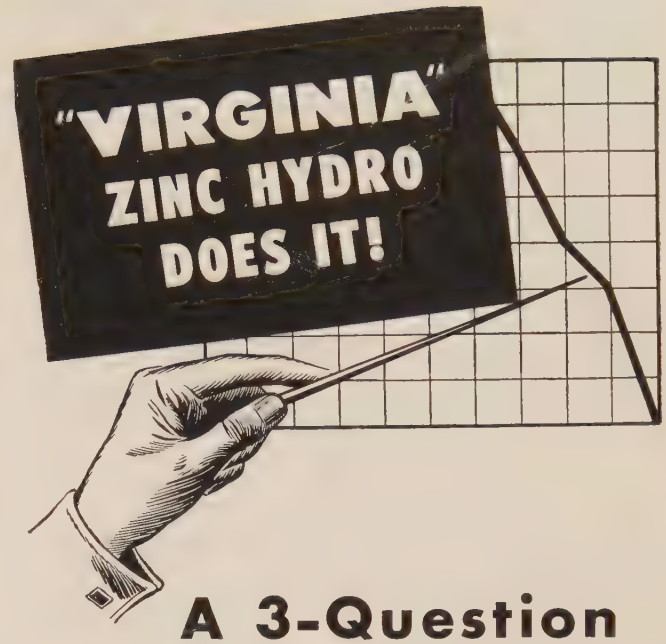
Under the date of February 17, 1953, the patent listed as 2,628,640 (Pulp Molding Machine and Process) should be changed to 2,628,540.

C. B. Sitterson, Jr., *Secretary*
Institute of Paper Chemistry
Appleton, Wis.

Tall Oil

To the Editor, *Tappi:*

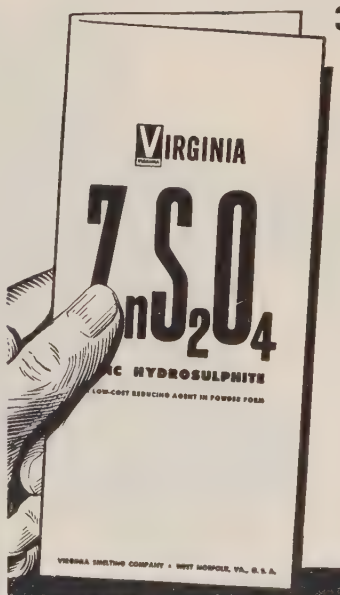
Do you have available data on the production and processing of tall oil and sulphate turpentine by the southern kraft



A 3-Question Quiz on Economy

"Virginia" Zinc Hydro has been used as a groundwood bleach long enough for its brightening properties to be proved. Groundwood mills contemplating installation of a bleaching process should consider these questions:

1. What increase in brightness can be expected?
2. What will be the ton cost per unit of brightness to bleach with Zinc Hydro?
3. Is a capital investment for auxiliary equipment required in the Zinc Hydro process?



When you have the answers to these three questions, we predict an acute interest in "Virginia" Zinc Hydrosulphite. May we send you the answers with a product sample for testing purposes?

VIRGINIA SMELTING CO.
Dept. 77-P, West Norfolk, Va.

Field Offices:
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BOSTON
DETROIT
CHICAGO
PHILADELPHIA
ATLANTA

VIRGINIA Chemicals
SINCE 1898

paper mills? We are particularly interested in answers to the following questions:

1. What per cent of the "black liquor" produced was converted into tall oil in 1952?
2. What was the total tonnage of crude tall oil produced in 1952?
3. What was the total tonnage of crude tall oil processed and sold as "refined tall oil?"
4. What was the tonnage of tall oil fractionated to sulphate rosin and fatty acids?
5. What per cent of the sulphate turpentine produced in 1952 was recovered for sale, the remainder being burned or otherwise discarded?
6. What was the total tonnage of sulphate turpentine recovered in 1952?

ED M. MILNER, *Assistant Chemical Engineer*
Dixie Pine Products Co., Inc.
Hattiesburg, Miss.

To the Editor, *Tappi:*

I wish to acknowledge your recent letter in which you ask specific questions as to the production and processing of tall oil and sulphate turpentine by southern kraft mills.

For your convenience I will answer the questions in the order listed in your letter.

1. There are no over-all figures to indicate the per cent of all black liquor produced by the industry into tall oil in 1952. Assuming a conversion factor of approximately 50% the indications are that around 315,000 tons of tall oil skimmings were recovered during the year.
2. According to the Bureau of the Census crude tall oil produced in 1952 amounted to 156,284 short tons.
3. According to the Bureau of the Census figures refined tall oil production in 1952 amounted to 51,430 short tons. The Bureau gives no figure for the amount of crude used to produce this quantity of refined tall oil.
4. To my knowledge there are no figures available on the tonnage of tall oil fractionated to sulphate rosin and fatty acid.
5. I am not in possession of any figure which would indicate the per cent of sulphate turpentine recovered for sale in 1952.
6. The Department of Agriculture reports sulphate turpentine production for the 12 months ended March 31, 1953, as being 169,560 barrels as against 203,430 barrels for the preceding crop year.

T. K. HESTON, *Assistant Secretary*
Tall Oil Association
New York, N. Y.

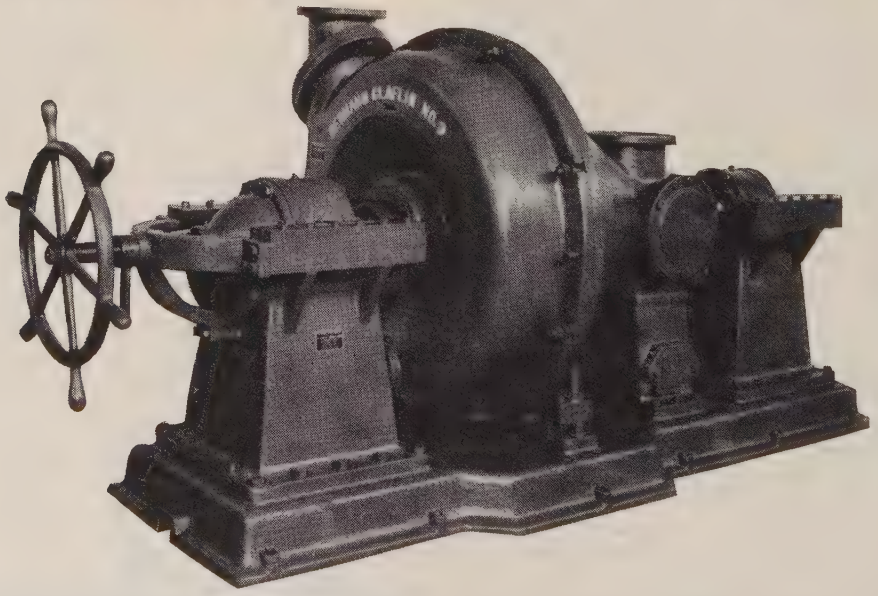
TAPPI Engineering

To the Editor, *Tappi:*

In the August issue of *Tappi*, pp. 74A–77A Mr. Bloomquist's article entitled, "What You Should Know About The TAPPI Engineering Conference" is before me, and I wish to congratulate him on trying to pull together such an article, because I am sure that the TAPPI activities mean something different to just about every member.

In my association with the Armstrong Cork Co., I come into rather close contact with several different industries, and it has been my impression that there is a considerably freer and more comprehensive exchange of information within the paper business than within any of the other industries with which I am familiar. I believe that this free exchange of technical information is a trend to which all of our industry must move in the future, but I believe that TAPPI has been the one responsible for getting this situation so well advanced within the paper industry. To get a trend of that type started requires years of patient plowing, and I believe that the results of Mr. Macdonald's efforts to keep TAPPI as an educational insti-

HERMANN *Improved* CLAFLIN



New No. 3 Heavy Duty Unit with Tangent Head-Volute Inlet.

For Defibering Hot Brown Stock and Other Stocks. From 250–400 T/Day.
From 250 to 350 H.P. No. 3 Claflin Installations in Seven Southern Mills.

THE HERMANN MFG. CO., LANCASTER, OHIO

tution reflect this; and to him, I believe, a great deal of the credit belongs.

I believe that it is rather remarkable the way in which new technical developments are quickly disseminated throughout the industry, and I know that my associates are always amazed at the extent and type of information circulated by TAPPI and done in such a manner that the mills still are competitive. Do you know of any industry that would or could put on a program such as was put on by the Chemical Engineering Committee when dealing with the subject of semichemical pulping? As you will recall, they had an afternoon when they had the manufacturers, the users, the technical men giving a series of approximately eight papers dealing with all phases of semichemical pulping. I believe that that program was outstanding.

It is, therefore, my opinion that TAPPI not only is advancing the whole paper industry, technically, very rapidly; but that in the process of doing so, they are also broadening the technical men in each of the various mills and giving them an opportunity to grow.

JOHN D. LYALL, *Project Engineer*
Armstrong Cork Co., Lancaster, Pa.

New England-Maine-New Hampshire

To the Editor, *Tappi:*

I am somewhat distressed concerning the accounts of my paper at the Poland Spring meeting which has appeared in print (*Tappi* 36, No. 8: 149A–150A, Aug., 1953). I feel that I must disclaim responsibility for most of the statements attributed to me.

For example, I did not say that there were 42 standard grades of paperboard, but rather that there were 42 grades of wastepaper. I am also quoted as saying "that the paper used must give good penetration, have compressibility, a good surface, and lateral porosity." I will admit that a good surface is desirable, if anyone knows what a "good" surface is, but the rest is so much nonsense. What is "good penetration?" The penetration should be suited to the type of printing to be done. Any paper or board has compressibility; the problem is how much, and how evenly is it distributed?

And I had a feeling all along that I shouldn't have used the words "lateral porosity," as I did, as a means of classifying the air-flow method of testing smoothness. Actually, the lateral porosity of the sheet being tested is an important source of error in the testing method, but its presence in the sheet is of little consequence as far as the printing operation is concerned.

Although I freely admit to only meager knowledge of board, and less of printing, I would hate to have anyone think I know as little as the account in *Tappi* would seem to indicate.

H. W. VERSEPUT, *Research Dept.*
Robert Gair Co.,
Uncasville, Conn.

Fiber Analysis of Paper and Paperboard

To the Editor, *Tappi:*

I would like to bring to your attention a few comments regarding the revision of TAPPI Tentative Standard T 401 m-42, Fiber Analysis of Paper and Paperboard (*Tappi* 36, No. 8: 170A–178A, Aug., 1953).

The following comments are concerned with the Appendix, part A, Morphological Characteristics:

The statement is made that the black gums and tupelos are readily separated from other hardwoods except sweet gum by the relatively large number of bars in the perforation plates. I am not familiar with the amount of fiber products now being made from the birches, but I would like to point out that they, too, have many bars.

THE SWING IS TO THE NEW

Line pictured at right is producing coated paper at continuous speed of 600 f.p.m. Automatic roll changes effected at both ends of line.

WALDRON . .

Automatic UNROLL

Accelerates New Bundle, Effects The Splice And Cuts Off Old Web Under Continuous High Speed Push Button Operation

The new WALDRON automatic unrolls are available in various types for moderate and high speed operation. A rugged and relatively inexpensive machine that will splice bundles of from 24 inch to 60 inch diameter. For details write for our Bulletin 1007.

Our modern Laboratory is available to evaluate recommended processes. Submitting samples will assist us in our laboratory analysis of your particular problem.

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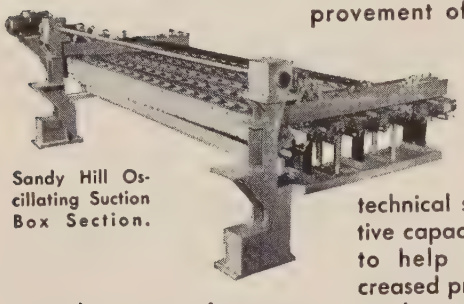
P. O. BOX 791 · NEW BRUNSWICK · NEW JERSEY
Leaders In Web Process Engineering Since 1827

Modernization for Specialization

SANDY HILL is ready and equipped to serve you, whether your individual requirement is a new paper machine for a highly specialized purpose or the installation of new facilities for the improvement of existing mills.



Sandy Hill Oscillating Suction Box Section.

Whatever your problem may be, Sandy Hill's technical skill and productive capacity are available to help you attain increased production of high quality paper, economically and profitably.

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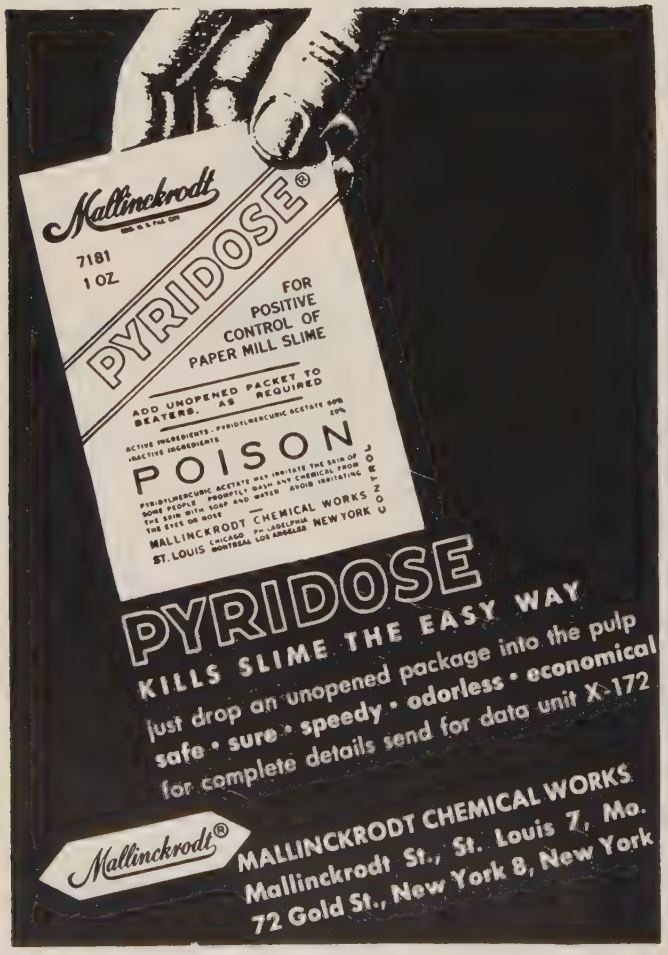
Associated with Canadian Vickers, Ltd., Montreal, Builders of Sandy Hill Designed Machinery in Canada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FOR POSITIVE CONTROL OF PAPER MILL SLIME
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The statement is made, also, that sweet gum can be separated from the black gums by the presence of spiral thickening in the vessel segment tips. Both the "Textbook of Wood Technology" (Brown, Panshin and Forsaith), and *Tropical Woods* (No. 73, March 1, 1943), state that Nyssa occasionally has spiral thickening in the vessel segment tips. Perhaps a better statement would be to say that the spiral thickening in sweet gum is more common. In the course of teaching fiber identification for the past three years I have found that the use of this feature alone is not at all decisive in separating sweet gum from the black gums.

HAROLD A. CORE, *Instructor of Wood Technology*
New York State College of Forestry
Syracuse, N. Y.

Adhesion of Films to Metals

To the Editor, *Tappi:*

I have read with interest the article on "Some Recent Progress in Measuring Adhesion of Films to Metal Plates" (*Tappi* 36, No. 6: 16A (1953)) in which H. F. Mark discusses an adhesion test method recently developed by K. Wolf and collaborators in Germany. During the question period following Dr. Mark's discussion, reference was made to comparative data obtained at the National Bureau of Standards using both the adherometer and centrifuge adhesion test methods.

We at N.B.S. are anxious to dispel the impression that all the comparative tests were made here. Although the adherometer work and the attempt to correlate it with measurements were done by us, the centrifuge tests themselves were made by W. Soller and his associates at the University of Cincinnati where the ultracentrifugal adhesion tester was developed and is now located. The comparative data for the two methods of test are reported in a paper entitled "Evaluation of Adhesion of Organic Coatings by Ultracentrifugal and Other Methods" under the joint authorship of W. Soller, A. M. Malloy of the Navy Bureau of Aeronautics, and the writer. A preliminary transcript of the paper appeared in the September, 1952, preprint booklet of the Division of Paint, Varnish and Plastics Chemistry; publication is pending in the *Paint, Oil and Chemical Review.*

In our adhesion paper referred to above, we suggested that the reliability of the adherometer could be considerably improved if the variable stripping force values usually yielded by the instrument could be averaged by some electronic means. Equipment to accomplish this has recently been developed in this laboratory. A beam and strain gage are substituted for the conventional adherometer pendulum as a source of the stripping force needed at the cutting head. Variations in the strain gage element are fed into an electronic integrating device whose output is calibrated so as to indicate the average value of the stripping force directly, either on a voltmeter or on a standard recorder. A preliminary description of this device was presented at the recent Gordon Research Conference on Organic Coatings at New Hampton, N. H.

A. G. ROBERTS, *Organic Plastics Section*
National Bureau of Standards
Washington, D. C.

RECENT BOOKS

Pumps. 2nd Ed. By Frank A. Kristal and F. A. Annett. McGraw-Hill Book Co., New York, 1953. Cloth, 6 × 9, 373 pages. $6.50.

Mr. Kristal represents three pump companies in New

York City. Mr. Annett is contributing editor of *Power*. The second edition brings up to date the information published in the 1940 edition. With more than 400 illustrations, the text is essentially a handbook on the subject covering such pump types as reciprocating, centrifugal, turbine, propeller, rotary, deep-well, boiler-feed sewage, and sludge, also such subjects as priming pumps, economical pipe sizes for pumps, pump operation, pump selection, and centrifugal pump troubles and remedies.

Handbuch der Werkstoffprufung. 2nd Ed., Vol. IV. Papier-und Zellstoffprufung. Edited by Rudolf Korn and Friedrich Burgstaller, Berlin-Dahlen. Springer-Verlag, Berlin, Germany. Cloth, $6^1/_2 \times 9^1/_2$, 567 pages. 375 illustrations. (DM 87.) ($20.88.)

The second enlarged edition of "Testing of Paper and Cellulose" replaces the first edition issued in 1944. Complete testing procedures are given relative to methods for evaluating wood, pulp, and paper. References are made to the current TAPPI Standards and the methods approved in Sweden, Great Britain, Finland, and Germany. In addition to 375 illustrations a large number of photomicrographs, some in color, are appended to the text.

In the United States the book may be purchased from Lange, Maxwell & Springer, Inc., 122 E. 55th St., New York 22, N. Y.

Kurzes Lehrbuch der Cellulosechemie. By Prof. Th. Lieser, Darmstadt, Univ. Berlin-Nikolassee, Germany (Au der Rehiviese 4), Gebruder Borntraeger Verlagshuch, handling, 1953. Cloth, $6 \times 8^1/_2$, 288 pages. Illustrated. (DM 36.)

The author refers to the excellent books previously written by Drs. Heuser and Ott. The present text brings the subject of cellulose chemistry up to date particularly for the benefit of students.

Included among the subjects covered are the reaction of cellulose and water, the influence of concentrated salt solutions and strong acids on cellulose, the reactions of cellulose and alkalies, cellulose esters, cellulose ethers, the degradation of cellulose, synthesis and constitution of cellulose.

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E243-53. Production Superintendent. Well qualified in the manufacture of fine specialty grades. Yankee or fourdrinier machines. Capable of taking full charge of operation. Middle aged. Married.

E247-53. Technical Executive. B.S. chemistry with graduate work. Married, two children. Desires position having a good future with a responsible corporation. Experience in research development, management, and technical sales. Excellent references.

E248-53. Graduate Mechanical Engineer. 39, president and general manager of fully integrated paper company (owning timberlands, converting part of paper output, employing over 600, annual sales over 10 million dollars) until recent acquisition by larger company. Seeks position of management responsibility with a progressive concern.

E249-53. Expert—Pulping and Bleaching. 24 years of fruitful research and development. Present position administration of a large mill research department. Desires executive position where initiative and job enthusiasm will be appreciated.

E250-53. Mechanical-Industrial Engineer, 31. Manufacturing and design background in paper, board, and packaging.

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Self-contained ELECTRO-HYDRAULIC drive — proved by hundreds of pendulum predecessors. Smooth — even — shockless loading.
Ranges: Literally grams to tons in one instrument.
Can be operated at constant rate of extension or to break in given time interval.
Cyclic operation under load or extension at high or low rates.
Finger tip control. One switch for routine tensile testing.
Strain gage weighing is frictionless and without inertia.
Pulling speeds infinitely variable between 1/10 and 25 inches per minute.
Completely adjustable operation in both directions of stroke.

THWING-ALBERT INSTRUMENT COMPANY
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103

For the OYSTER'S COMFORT

The oyster shell, rugged and rough on its exterior, is lined with a fine, smooth, highly-polished glaze to protect its occupant, Mr. Oyster. If a grain of sand intrudes, it too is promptly protective covered—forming a valuable pearl.

Protective linings and coverings, specifically formulated to meet the corrosion or abrasion problems of *your* equipment are our business. Long-wearing rubber or synthetic sheeting can be applied in our plant, or in yours by skilled field crews.

Unusually fast delivery is our strong point—especially when new steel construction is needed, since Acme-Fisher does the complete job. And our prices are right. Ask us for an estimate.

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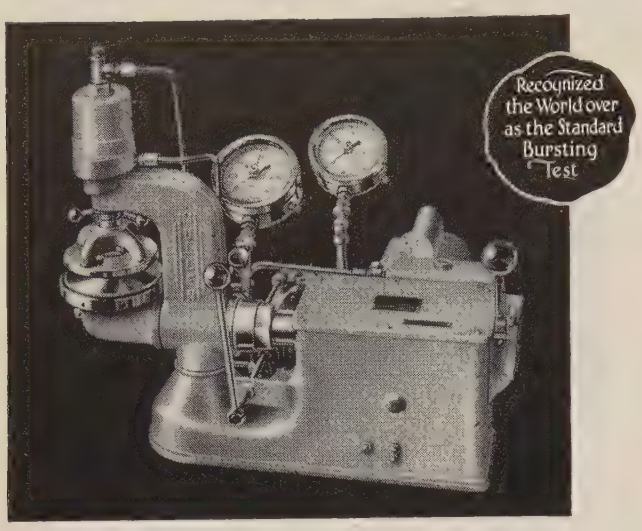

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I would be interested to meet interested parties to discuss the subject in more detail. I have had more than 15 years' experience in the field of paper, treatments, and coatings.

E252-53. Executive Chemist. M.S. Two years toward Ph.D. at pulp and paper school. Twenty years' experience as chief chemist, laboratory director, and consultant on process and quality control, research and development, purchasing and sales aid in paper, board, fibers, adhesives, plastics, primarily in automotive trim field. Reduced costs, improved processes and products. Seeks position as research or technical director, or in related work, with greater responsibilities and opportunities. Midwest location preferred.

E253-53. Wanted. A production job by a technical graduate. 31. Six years' highly diversified experience in research, development, quality control, and mill operating problems. Presently in charge of technical department of integrated kraft pulp and paper mill making fine, wrapping, and specialty grades. Location not important. Salary, secondary to opportunity.

E254-53. Paper Chemist, age 27, with B.S. degree in chemical engineering. Married with one child. Three and a half years' experience in research and development, technical service, and quality control.

Positions Open

P323-53. Quality Control Supervisor. To supervise installation of quality control program in midwestern corrugated box and folding carton plant. Prefer man experienced in both quality control and production.

P328-53. Chemical Engineer or Chemist to head research and quality control department of progressive carton manufacturer in the south. Experience in packaging field helpful but not essential. Must be up to date in the field of coatings, plastics, adhesives, etc., and must be able to develop new ideas.

P328-53. Chemical Engineer or Chemist. To head Research and Quality Control Dept. of progressive carton manufacturer in South. Experience in packaging field helpful but not essential. Must be up to date in the field of coatings, plastics, adhesives, etc. and must be able to develop new ideas.

P330-53. Chemist or Chemical Engineer with pulp and paper background for integrated mill in Middle Atlantic. Please reply, giving education, experience, personal data, reference, and salary expected.

P331-53. Paper Salesman. Established manufacturing concern desires young man between 30–35 years of age to sell chemical specialties to paper industry. Qualifications must include experience in technical or production end of paper industry. Chemical background essential. Excellent opportunity for men demonstrating initiative and sales ability. Please give details of education, experience, and salary desired.

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P336-53. Manufacturer of paper chemicals desires chemist or chemical engineer for research and technical service. Experience in the evaluation and manufacture of paper required. Location Gulf Coast. Our employees know about this ad. Send complete information on education, experience, and starting salary desired, also a photograph.

P337-53. Large manufacturer of paperboard and cartons has opening for a chief chemist in its research laboratory. Excellent opportunity for a young chemist with experience in these fields having supervision ability. Ph.D. or equivalent status required.

MISCELLANEOUS

A-4. Wanted: Bound copies of Technical Association Papers of the following years—1925, 1926, 1930, 1933, 1936, 1938, 1939, 1940, 1941, 1945, and 1947. Reply to Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York 17, N. Y.

White Water Utilization

PAUL J. SCHMITT

THIS paper deals with the problems of one mill in utilizing paper machine white waters in excess of those re-used within each machine system. While the majority of the white waters can be re-used directly, or after stock-water separation in one of the various type savealls, there are excesses both in normal operation and as a result of change-offs, shutdowns, and spills.

In order to clarify these excess waters and reclaim the stock, settling tanks were constructed some 20 years ago in the abandoned mill race. A wall was erected lengthwise in the race to form two adjacent tanks about 140 ft. long. The larger, or no. 1 tank, was 14 ft. in width and held about 90,000 gal., while the no. 2 tank was more narrow and held 50,000 gal.

PAUL J. SCHMITT, Chemical Engineer, P. H. Glatfelter Co.

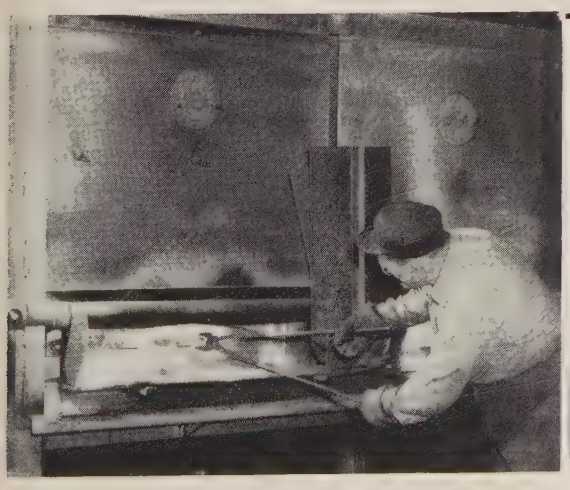
All white and clarified water not re-used within the individual machine systems was sent to the east, or inlet end, of the no. 1 tank. The water flowed the length of the tank where retention time was great enough to allow the majority of the solids to settle out. The settled stock was drawn off at intervals and recovered through the wet machine system. From the west end the water overflowed into no. 2 tank which supplied the mill as the water was needed. Originally the clarified water was used on the paper machines, but as the mill expanded, the water came to be used almost completely in the pulp mill and bleach plant.

Over a period of years, the flows into no. 1 tank increased, while the efficiency dropped markedly to 65% with particularly low efficiencies occurring in times of sudden heavy or "shock" loads.

The most troublesome result of the low efficiencies was a decided drop in the brightness of the stock as it went over the bleach plant washers where the water was used for showers and dilution. Also, because of the large amount of fines and clays in the water, the washers occasionally became clogged, causing overflows to the sewer and necessitating shutdowns. Furthermore, a considerable amount of solids was lost in the occasional overflows from no. 2 tank to the sewer.

In view of the unsatisfactory condition of the system, an investigation was undertaken to determine its general operating characteristics and to pin-point the various sources of trouble. Emphasis in this investigation was put on retention time which was believed to be too short to handle the greatly increased flows. A study of such conditions as settling time, linear velocity, and turbulence indicated that the system was not capable of handling in a satisfactory manner the large volumes and heavy solids entering no. 1 tank. However, a very significant point was brought out, namely, that approximately half of the flows entering no. 1 tank were very low in solids content and required no further clarification. If these waters were to by-pass no. 1 tank and enter no. 2 tank directly, it was felt that the remaining flows, high in solids content, would then have sufficient retention time in no. 1 tank.

The separation or segregation of the rich and clarified lines presented numerous difficulties. All water entered the system at the east end of no. 1 tank, there having been no need for segregation of rich and clarified water at that time. Thus, when the system was put into operation, and later expanded, excess water from all machines as well as deinking had been sent through the same sumps and pipes whenever possible. Emphasis had been placed, naturally, on utilization of existing pipe lines and other facilities, creating a network which had to be redesigned according to solids content of the water. Further, if the clarified water from the settling tanks was to be most advantageously used, it was necessary to take into consideration the points and rate of usage in the pulp mill and bleach plant. Segregation, therefore, could not be undertaken without a clear picture of all fresh, clarified, and



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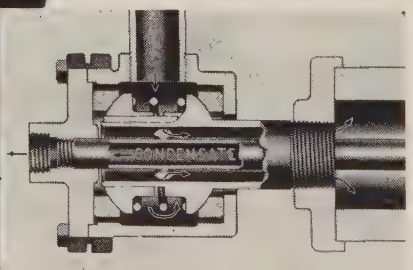

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white water lines, their location with respect to each other, and the rate of flow through each. Recognizing this, the first phase of the work was centered about diagramming the mill water system.

Schematic drawings were available for all paper machines as well as for parts of the mill fresh water and sewer systems. These were brought up to date and extended to include all other processes in the mill, consisting of the pulping, bleaching, deinking, and purchased pulp slushing operations. Layouts of the settling tanks and surrounding area were drawn to scale in order to assist in the considerable amount of maintenance work which it was expected would be necessary.

After the diagramming was completed, it was possible to begin evaluation of flow rates and solids contents. It was necessary to find the maximum and minimum as well as the average flows since this information was needed in determining where existing pumps, lines, and other facilities would be adequate to handle the flows after the system was revised. In one or two cases where the flows of rich white water into a sump were infrequent, a small clarified line was turned into the sump to assure regular pumping out and prevent stagnation.

Flow rates were determined by using a wide variety of general engineering methods. Material and water balances were performed on all paper machines, tanks were drawn down and the rate of fill-up determined, weirs were installed where possible, and the discharge from horizontal pipes was calculated by formula. In the case of flows out of sumps, recording pressure gages or ammeters were used to determine the number of on-off cycles per day as well as the length of time of each. Since the complexity of the system ruled out any instantaneous determination of all flows, the results were an accumulation of several months' data. While metering equipment would have given more exact values, it was not felt that the added expense would be justified. Indeed, exact values would have no great significance since the flow rates varied so widely and since it was necessary to consider the possibility of increased average and maximum flows due to normal mill expansion.

Solids content of the white water were determined on a pounds per 1000 gal. basis, using a Buchner funnel for filtering. Numerous check points were designated throughout the mill and quart samples taken regularly until sufficient data were obtained. Flows having solids values in the neighborhood of $^1/_2$ lb. per 1000 gal. or less were considered satisfactory for direct entrance to no. 2 tank.

With the necessary data on flows and solids available the segregation of rich and clarified lines was carried out by maintenance crews and the revised system put into operation. The changes proved to be quite effective with the efficiency rising to about 90% and the effluent generally averaging about 1 lb. per 1000 gal. or less, except during periods of heavy or shock loads; during such periods of operation the efficiency dropped considerably. However, the improvement from segregation alone was considered quite satisfactory and attentions were then turned to other means of improvement, namely, elimination of turbulence and channeling.

It should be mentioned that no attempt was made to improve settling by the addition of flocculating agents. Flocculants were not believed to be necessary since such chemicals as alum and glue were added in the paper machine systems. These were present in the white water in sufficient quantity to bring about the desired flocculation when other conditions were satisfactory.

Turbulence was especially pronounced in no. 1 tank where there are several influent lines and all vary widely in flow rate. Actually, it was so pronounced that little settling took place until the waters had traveled about 50 ft., or one third the length of the tank. To reduce turbulence two sets of baffles were installed, the first 30 ft. from the influent end and the second at the midpoint. It was found that the first set alone did the job quite satisfactorily. During periods of high

flow rates, however, the increased velocity of the water as it passed the second set of baffles had a tendency to stir up the large amount of stock settled out in this area. As a result of this condition the second set of baffles were removed.

Corrective measures were then taken on the channeling which existed in no. 1 tank. As mentioned previously, the two tanks have a common wall. After flowing the length of no. 1 tank, the water discharged into no. 2 tank through a 3-ft. opening in this wall. Flows from no. 1 tank channeled toward this discharge point to such an extent that some 10 to 15% of the available space was not utilized. To correct this condition a trough was set across the no. 1 tank at the discharge end. The water then followed a more nearly straight path and discharged into the trough which then emptied into no. 2 tank through the old opening.

During the period following completion of the improvement program, the settling tanks were kept under close surveillance. Efficiencies in no. 1 tank rose to an average of 90% with solids in the effluent generally being less than $^1/_2$ lb. per 1000 gal. In all cases shock loads were satisfactorily handled, the solids in the discharge during these periods never reaching 1 lb. per 1000 gal. As a result, while there was still some drop in the brightness of the stock as it passed over the bleach plant washers, it was far less pronounced than in the past. Clogging of the washer screens decreased about 90% so that this particular difficulty became the exception rather than the rule. Overflows from no. 2 tank to the sewer could not be eliminated, but with the improved clarification there was a considerable drop in solids losses from this source. Thus the over-all benefits from the improvement program were threefold, resulting in higher brightness of the stock, less operating difficulties in the bleach plant, and a reduction in loss of stock to the sewer.

Received Sept. 15, 1952. Presented in competition for the Albert Award, Delaware Valley Section of the Technical Association of the Pulp and Paper Industry.

Building a Library Collection for the Pulp and Paper Curriculum at Western Michigan College of Education

TAISTO JOHN NIEMI

It is difficult for me to put into words the pleasure I am enjoying at this moment. I realize that it isn't often that a librarian has the privilege of appearing before the members of TAPPI. In fact, it is highly possible that I am the first.

Mr. Macdonald, in an address at the mid-year graduation exercises at our school last year, stated that "the establishment of the pulp and paper curriculum at Western Michigan College was a brilliant innovation instigated by someone with real imagination and foresight." I would add to that a degree of persistence, for if we look back in history we will find that 10 years ago such an attempt was made without immediate results.

Where persistence kept alive the idea, cooperative effort brought forth success. It was through the joint work of the administration at Western Michigan College, the representatives of the paper industry in Michigan and throughout the United States, and the good work of the members of the Kalamazoo Valley Section of TAPPI, and the Michigan Division of the American Pulp and Paper Mill Superintendents Association that the pulp and paper curriculum came into being.

It would be only natural for such a curriculum to be instituted in Kalamazoo. Out of the 49 establishments for manufacture of paper and paperboard in Michigan, Kalamazoo

Taisto John Niemi, assistant cataloging librarian and librarian of the Library Annex, Western Michigan College of Education, Kalamazoo, Mich.

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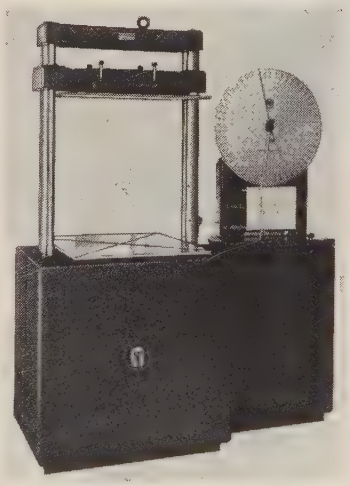
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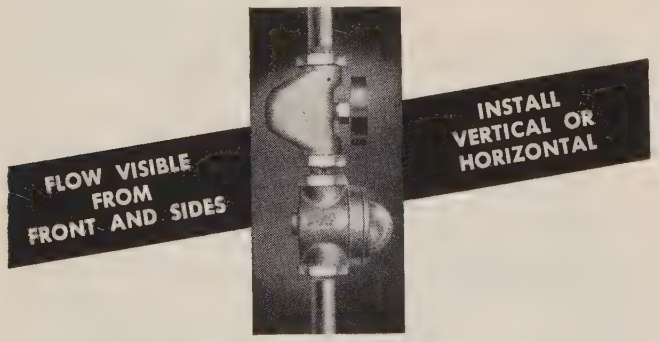

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has 12. Kalamazoo, then, is doing its part in helping to keep Michigan at the top in manufacture of paper and paper products.

In the Fall of 1948 the pulp and paper curriculum had only 6 enrollees. The following year there were 24 and since then the enrollment has risen to approximately 60 students.

The college was fortunate in obtaining a man to head this program, who not only has proved outstanding as a teacher and research worker but who has also shown ability in handling public relations and matters of organization. Alfred Nadelman, the head of the curriculum in pulp and paper technology, is assisted by an unusually fine staff made up of a graduate of The Institute of Paper Chemistry, a graduate of the University of Maine, and a graduate of our own college.

In the Fall of 1948 immediate steps were taken by the general library to establish a nucleus collection for pulp and paper. The library subscribed to 15 of the major paper periodicals and ordered what paper texts there were in existence at that time. At the time the library was fortunate in obtaining a part of the collection of the late Charles Weber, formerly with the National Bureau of Standards. The library was able to purchase from his collection many important reference works. West's *Bibliography of Paper Making*, and TAPPI *Papers*, *Data Sheets*, *Standards*, and *Monograph Series* were obtained in this way.

I spoke of the cooperation of the paper industry throughout the United States that took part in setting up this program. This can be attested to by the thousands of dollars of equipment that went into the laboratory of this department. In that first year some of the local Kalamazoo paper men gave some of their texts to the library. Thus the year 1948/49 saw the beginning of a full-fledged program in pulp and paper technology with seeds of a library collection.

The same year something fortunate took place in regard to pulp and paper. In the Fall of 1949 a new science building was opened up on the west campus of the college. The fortunate part of the story comes in the fact that library facilities were made available in a special room on the main floor of the building. This Physical Sciences Library was organized to service chemistry, physics, and pulp and paper technology. The major part of the books in these fields were brought into the new branch library. As far as were available, periodicals to be found abstracted in the *Chemical Abstracts* were brought over. I had the good fortune to be appointed to supervise this new library.

It should be pointed out here that we did start with a good, solid collection in physics and chemistry and the allied fields of nucleonics, astronomy, industrial chemistry, electrical engineering, and physiological chemistry.

It was quite obvious that what the Physical Sciences Library then had on hand in the field of pulp and paper would not be sufficient to take care of research and reference needs. It was stated at that time that during the next year all the seniors would be assigned a research paper to be written on some phase of pulp and paper technology. This made it doubly important that materials be on hand.

Immediate help again came from the local paper industry. The most notable help came from the Dunn Paper Co. of Port Huron, Mich.; Edgar Brothers Co. in McIntyre, Ga.; and the Michigan Paper Co. and Kalamazoo Vegetable Parchment Co. in Kalamazoo. Several thousand items, mainly periodicals, came from them. The immediate job was to go through them and see what could be used by the library. Out of this vast gift the science library was able to add greatly to its meager holdings in pulp and paper technology. The rest were duplicates and were to be used for exchange purposes about which I will tell you now.

In accepting the gift the library was happily allowed to decide what was to be done with the duplicates received. Some 30 to 40 colleges and research libraries were contacted throughout the country telling them of our needs and offering our duplicates for exchange. Some 15 replies were received

and out of these we were able to effect exchanges with 6 of them. Two research libraries offered to buy outright several part-sets of our periodicals. In this way, the library was able to pay for some of the transportation costs involved in receiving exchanges from the other libraries.

Several progressive changes had taken place in the pulp and paper area which added to the importance of building our library collection. Research work for the Kalamazoo River Improvement Co. and the United States Army Quartermaster Corps was started and required additional services from the library. Help came again through cooperative effort.

The cooperation I spoke about in the organizing of the pulp and paper curriculum was gained mostly through the work of the Advisory Committee for Pulp and Paper Technology—a committee which was in existence for the purpose of obtaining the fullest team work from industry, education, and technical experts in the setting up of this program. One of the special committees was the Library Committee, organized to aid in making contacts in the paper industry and to keep alive the interest in the needs of the library. Besides Fred Chappell, the chairman, the Library Committee at the present time is made up of O. W. Callighan of Edgar Brothers, W. A. Kirkpatrick of Allied Paper Mills, S. I. Kukolich of the Lee Paper Co., Alfred H. Nadelman, and T. T. Elias from our own faculty, A. L. Sherwood of the Sutherland Paper Co., Miss Katharine M. Stokes, our head librarian, and myself as acting secretary. Since the existence of the committee, the library has received many important gifts from individuals and companies. I would like to express the appreciation of the library here by mentioning some of those people who gave gifts to the library: O. W. Callighan, Fred Chappell, George Dunn, Robert Drummond, Mrs. Joseph Kindelberger, William Kirkpatrick, A. T. Luey, Alfred H. Nadelman, L. J. Scheid, and Dwight Stocker.

There is one other important phase of our development program that I would like to mention here. Our part in this program has come about mostly because we have had duplicates to offer. The United States Book Exchange, Washington, D. C., is a nonprofit organization which is organized to allow libraries in this country and abroad to obtain periodicals and book materials that they can obtain in no other way. The exchange is operated on a system of debits and credits on magazines sent in and requests filled. Our library thus far has sent to the exchange over 1000 periodical items. We have received many completed and partial volumes of periodicals to fill in our holdings—items that we would most likely be unable to get anywhere.

In the past year our exchanges to other libraries have not been entirely handled through the Book Exchange in Washington. As soon as it became known that North Carolina State College in Raleigh and the Lowell Textile Institute in Massachusetts were instituting pulp and paper technology curriculums, we wrote to these institutions at once. Within 2 weeks Lowell Institute and North Carolina State College received some 50 volumes of our paper periodicals in exchange for their duplicates.

I do not intend to ignore the importance in which the college and the library administration have held this program. Both the administration of the college and the library have been most generous in allowing the purchase of books, periodicals, and nonbook materials which have been urgently needed by the science library. The one main item which has been completed by the General Library is the *Chemical Abstracts*. Our file of this impor-

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NEWBURGH, NEW YORK

tant work is complete, including the decennial indexes. The General Library has spent over $200 per year on subscriptions and binding of current periodicals. At the present time approximately $100 is spent by the library on book materials. In round figures the General Library has spent well over $5000 thus far on building up the pulp and paper technology collection.

In regard to nonbook materials, the library purchased a microfilm reader machine worth $225 in conjunction with the purchase of microfilms for students doing research work. Another expenditure by the library is Beilstein's *Handbuch der organischen chemie* on microcards and a microcard reader. Both of these items amounted to more than $300.

The international aspect of the pulp and paper program is quite interesting. This year we have one student from Pakistan and one student from Austria. Next year we will add Spain, Mexico, and France to the roster. The program does not only attract foreign students, but encourages our students to study foreign languages. Most of the future papermakers study either French or German. Thus, our students get some use out of Beilstein and periodicals like *La Paperterie* and *Das Papier*.

In the past 3 years we have progressed from practically point zero to where we feel that our collection means something. In the year 1950/51, the first year that senior theses were required, the library and the pulp and paper curriculum purchased some hundred dollars worth of microfilms in order to put into the hands of students articles that were not provided them from our own holdings. Today, though the class is triple in size, the amount expended is less. This is a fair indication that our library collection is meeting some of the needs of the students.

This year the pulp and paper collection has a new home. The college now has a new administration building. Within this building was assigned larger quarters for the science and pulp and paper collection. This new branch, now the Library Annex, has added library services for the more general curricula of the college. In spite of this fact, there is no intention of decreasing our interest in or service to the pulp and paper curriculum.

We have come a long way but we have a longer way to go. We have hopes of filling completely our files of the more general paper periodicals, and, of course, the Yearbooks of TAPPI. In this case, we need only volumes I to XII to complete our collection.

Now I have not been telling you of our needs without some purpose in mind. After 4 years of pedantic pleading, praying, plundering, and petitioning for pulp and paper periodicals, the game sort of gets into your blood. I think our library is a good case in point. I make not a plea for our own library in particular, but for all the libraries in the United States that are in need of help to fill their shelves with badly wanted research materials. It is possible that someone here this morning has in his attic, basement, garage, or even library, materials that would go far in answering the inquisitive quest of some paper student in some one of our colleges.

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Some Effects of Extreme Chip Packing in the Sulphite Process

ALAN S. ROSENFELD

Sulphite mills are utilizing chip packers to meet increased production demands without increasing digester capacities. Moderate chip packing, brought about by various types of chip distributors used during digester filling, allows up to 15% more wood to be put into a digester. Digester operation and pulp properties are not greatly affected by moderate chip packing.

Extreme chip packing puts 30 to 40% more wood into a digester. The literature reports that air-dry pulp yields as high as 6.9 lb. per cu. ft. of digester volume have been obtained by Scandinavian sulphite mills with extreme chip packing accomplished by a combination of chip distributors and chip steaming.

In the work reported herein, chip-packed and normal sulphite cooks were made under controlled conditions in an indirectly heated forced circulation laboratory digester. The problems considered were: (1) what yield of screened sulphite pulp per unit digester volume could be obtained from western hemlock wood with extreme chip packing, and (2) what effects extreme chip packing would have on pulp properties since chip packing means more wood and less cooking liquor in the digester.

EQUIPMENT AND MATERIALS

The experimental digester used for this work is made of stainless steel and has a capacity of about 7½ cu. ft. The cooking liquor is removed from the digester through a strainer near the top and is pumped through a four-pass heat exchanger, finally re-entering at the bottom of the digester. An automatic temperature controller regulates the rise to cooking temperature from a metal cam. The controller opens and closes a steam line to the heat exchanger as the cam moves through the temperature schedule.

A pressure controller operates an air-operated diaphragm valve on the top relief line to maintain the desired pressure. Although this valve operates automatically the relief line is equipped with a hand-operated valve on the high-pressure side of the automatic valve to give control to the rate of relief. Both wet and dry relief pass through this top line, into a cooler and then into the bottom of a stainless steel accumulator in which the original cooking liquor is made.

The volumes of the experimental digester and its acid circulation system were measured by weighing the amounts of water each would hold. The acid strainer volume was measured directly, and its volume was subtracted from the digester volume to give the actual space that chips could occupy in the digester.

Cooking liquor was made up, tested, and measured into the digester from a stainless steel acid accumulator equipped with a calibrated gage glass. For all cooks the total sulphur dioxide content of the liquor was 7.00 ± 0.2% and the combined sulphur dioxide was varied as desired.

Weighed samples of western hemlock wood chips, collected from the commercial mill wood supply system, were cooked with calcium-base sulphite cooking liquor. Packing the digester with chips was accomplished with a 4 by 4-in. wooden ramrod. Successive layers of chips were dumped into the digester and tamped down with the ramrod. The weights of oven-dried wood packed into the digester varied over a range of only 2½% in the different cooks.

EXPERIMENTAL PROCEDURE

The following types of cooks covered the variables examined in this work:

1. One standard control cook with no chip packing and normal combined sulphur dioxide (1.20%) in the cooking liquor.
2. One cook with chip packing, using normal combined sulphur dioxide.
3. One cook with chip packing, raising the combined sulphur dioxide in the cooking liquor so that the ratio of combined sulphur dioxide to moisture-free wood in the digester was the same as for the standard control cook.
4. One cook with chip packing, using an amount of combined sulphur dioxide in the cooking liquor intermediate between the raised and normal combined sulphur dioxide strength liquors.

All cooks were made with a maximum temperature of 275°F., a maximum pressure of 95 p.s.i., a 4½-hr. rise to temperature,

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and a 1¼-hr. blowdown to 35 p.s.i. Cooking liquor samples were drawn from the digester through a cooler during the cooks. Tests on these samples showed the progress of the cook and indicated when the cook was nearing completion.

The pulps were screened on a flat screen with four 10-cut plates and the screened pulps were dewatered in a centrifuge. Centrifuge loads were weighed and representative samples from these were oven-dried to determine the weights of oven-dried pulps. Screened pulp yields were based on the weight of moisture-free wood. Screenings were also collected, dried, and weighed. The per cents of screening were based on the weight of screened pulp plus screenings.

TAPPI permanganate number, G.E. brightnesses, and beater tests were made for each pulp, following standard procedures.

The rate of cooking in the sulphite process depends partly on the ratio of combined sulphur dioxide to wood in the digester. The higher this ratio is, the slower the rate of cooking will be. In operation, a sulphite digester is first filled to the top with chips and then acid is pumped in to fill the digester to the top. When more wood and less acid are put into a digester, as a result of chip packing, the ratio of combined sulphur dioxide to wood is lowered. Therefore, contrary to one's first thought a chip-packed sulphite cook will pulp in shorter time to a specified TAPPI permanganate number if no changes in acid strength are made. In this work, the total sulphur dioxide content of the cooking liquors was high enough to assure an excess of free sulphur dioxide for both normal and chip-packed cooks.

Variations of cooking times with consideration given to the ratio of combined sulphur dioxide to wood in the digester allowed all experimental pulps to be cooked to the same range of TAPPI permanganate numbers (12 to 15).

When irregularly shaped objects are packed in random fashion in any vessel, the degree of packing in the area adjacent to the wall cannot be as great as at a point distant from the wall. An original assumption that within ½ in. from the digester walls, the degree of chip packing would be about 50%, was verified experimentally. This was done in the following manner:

1. From three experimental chip-packed cooks, the figure of 6.4 lb. of air-dried pulp per cu. ft. of digester volume was established as the digester yield from any place away from the digester walls.

2. This figure, average screened pulp yield figures, and the average wood moisture figures were used to calculate back to the pounds of wet wood per cubic foot of digester volume that the digester could contain at any point away from its walls.

3. Three cylindrical vessels of different diameters were packed with wet wood chips. The actual weight of chips which each held agreed to within 4% or less to that weight which was calculated for these vessels, based on the assumption that packing would only be 50% as great within ½ in. of the vessel wall.

In a commercial-size digester (say, 12 ft. in diameter) only 1½% of its volume is within ½ in. of the walls, whereas in the 15-in. diameter experimental digester used for this work, 12.8% is in this region.

DISCUSSION OF RESULTS

Table I shows the results which extreme chip packing had on sulphite pulping properties. The maximum yield of screened western hemlock sulphite pulp realized from chip packing in the experimental digester was 5.98 lb. of air-dried pulp per cu. ft. of digester volume. In a commercial size digester where wall effects on chip packing would be minimized, this yield would be about 6.4 lb. of air-dried pulp per cu. ft. of digester volume.

Chip packing resulted in a 25 to 30% increase in the amount of oven-dried wood in the digester and a 23 to 26% increase in the yield of air-dried pounds of screened pulp per cubic foot of digester volume.

Table I. Chip Packing Effect on Sulphite Pulping Properties

Chip packing	*No*	*Yes*	*Yes*	*Yes*
Combined SO_2, %	1.20	1.21	1.43	1.76
O.D. wood in digester, kg.	31.5	39.4	41.1	40.8
Cooking liquor used, gal.	41.8	36.3	34.9	37.0
Combined SO_2 on basis O.D. wood, %	6.03	4.22	4.61	6.03
Pounds A.D. pulp per cu. ft. digester vol.	4.73	5.83	5.98	5.98
Total cooking time, hr.	8.5	8.25	8.5	9.0
Screened pulp yield, %	46.6	45.8	45.2	45.3
Screenings, %	0.8	1.2	1.2	0.8
G.E. brightness at 460 mmu, %	60.7	56.2	56.9	62.5
Bursting strength at 400 ml. Canadian standard freeness	138	138	136	147
Tearing resistance at 400 ml. Canadian standard freeness	1.17	1.15	1.06	1.30

By dropping the per cent of combined sulphur dioxide based on dry wood weight from 6.03 to 4.22% as a result of extreme chip packing, cooking time was reduced from 8½ to 8¼ hr. The slight loss in screened pulp yield from the chip-packed cooks is within the experimental limits for this work and does not reflect more drastic cooking conditions since pulp strengths were not affected. The G. E. brightness of this pulp also dropped 4.5% (from 60.7 to 56.2%) at 460 mmu. The amounts of oven-dried screenings varied little between normal and chip-packed cooks.

Raising the combined SO_2 to dry wood ratio for a chip-packed cook so that it equaled that for a normal cook did not affect screened pulp yields. An intermediate rise in the per cent of combined sulphur dioxide based on dry wood (4.61%) did not improve pulp strength or G. E. brightness. However, when the per cent of combined sulphur dioxide based on dry wood for a chip-packed cook equaled the per cent for the standard control cook, G. E. brightness increased 1.8%, bursting strength increased 6.5%, and tearing resistance increased 11%. The cooking time also increased from 8½ to 9 hr.

Cooking liquor circulation was greatly impeded by extreme chip packing. A satisfactory circulation rate in the experimental digester was maintained only because its pump had a large excess capacity. Acid pumps on commercial-size digesters would have to be able to overcome this increased resistance to circulation brought about by extreme chip packing.

SUMMARY AND CONCLUSIONS

Extreme chip packing in an experimental digester resulted in a 23 to 25% increase in the yield of air-dried screened pulp per unit digester volume for western hemlock calcium-base sulphite.

With no change in the combined sulphur dioxide of the sulphite cooking liquor, extreme chip packing caused losses of 4.5% in G. E. brightness at 460 mmu and 0.8% in the yield of screened pulp, caused no loss in bursting strength or tearing resistance, and shortened cooking time.

Adjusting the combined sulphur dioxide in the cooking liquor for a chip-packed cook so that the ratio of combined sulphur dioxide to moisture-free wood in the digester equaled that ratio for a normal cook, increased G. E. brightness 2 points, increased cooking time, and increased bursting strength 6.5% and tearing resistance 11%.

To translate digester yields from experimental-size equipment to commercial size equipment, one can assume that chip packing within ½ in. of a digester wall is only 50% as great as at any point away from the walls.

Extreme chip packing greatly impeded the circulation of cooking liquor in an indirectly heated forced circulation sulphite cooking system.

FOURTH TAPPI COATING CONFERENCE

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Coated Paper and Offset Lithography

Part I

A. P. REYNOLDS

THE middle thirties stand at the threshold of a new era in lithographic printing, not necessarily because this time marks the introduction of two sides coated litho papers, but rather because it marks the beginning of a demand in the lithographic industry for finer printing surfaces.

Before this time the producers of color lithography were few, and these few attained their effects by covering wove and special finish offset papers with six and seven colors. The bigger part of offset volume was black and white planographic reproduction, based on speed and price rather than quality.

There were many in the industry, however, who insisted that the offset lithographic process was capable of fine black and white and four-color reproduction, and it was through their insistance for better printing surfaces that coated two sides litho paper came into use. These early pioneers quickly adapted the coated surface to their use in the production of brilliant four-color reproductions for advertising booklets, broadsides, and catalogs.

But general acceptance came more slowly because the concept of a wove paper was traditional, and the techniques for lithographing wove papers were not adaptable to coated paper surfaces. Before coated lithographic papers could gain the broad acceptance they enjoy in today's market, two things had to take place. First, new materials and new printing techniques had to be developed within the process itself. Second, improvements had to be made in coated paper characteristics.

Looking back on this period, with regard to methods and materials, we can recall six good reasons why lithographers in general found coated papers more difficult to run than wove papers. These six reasons were: (1) ink (2) fountain solution, (3) blankets, (4) plate grain, (5) halftones, and (6) press adjustments.

LITHOGRAPHIC INKS

The ink manufacturer was limited in materials suitable for lithographic inks. Ink people made the best of what they had available in producing inks to meet lithographic requirements.

Lithographers required a greasy ink in order to keep the poor surface (albumin) images from going blind, yet they required a nongreasy ink in order to keep the poorly desensitized nonprinting areas from scumming and tinting. This paradoxical problem was accomplished by the ink manufacturer primarily by using heavy bodies varnishes with inherent high tack.

These very stiff inks could be run on the more tack-resistant wove papers, but they were not suitable for coated papers in tack, flow, or lay.

A. P. REYNOLDS, Director of Printing Research, S. D. Warren Co., Cumberland Mills, Me.

One of the pressroom prerogatives of this area was to "doctor" these stiff "wove" inks for use on coated paper. The "medicinals" used in this "doctoring" consisted of a broad variety of materials including corn starch, magnesia, boiled oil, lanolin, sheep tallow and kerosene. Some of these materials were not too harmful when used judiciously—others proved to be bad medicine. Some pressmen acquired skill in these ink manipulations—others did not. In general, results were never suitable to meet the highly intricate chemical balance required in lithography.

As a result of this, coated papers gained the reputation of being hard to print because inks picked, chalked, built, blinded plates, scummed, and failed to dry.

FOUNTAIN SOLUTION

In the early 1930's, litho pressmen were rugged individualists, particularly as far as fountain solutions were concerned. Little was known about the true purpose of their composition or their chemical relationships with ink, plate metal and paper. Each pressman had his own secret concoction of doubtful origin and unknown content—and particularly unknown pH.

The highly acid fountain solutions sometimes used to combat the greasiness of the doctored inks poisoned the metallic driers, particularly when emulsification was encouraged by certain types of additives.

The gum arabic content of fountain solutions was often increased to the point where it caused excessive blanket tack in the nonprinting areas and, thereby, prevented release of the smooth surface of coated papers.

Further, this lack of standard practice in the industry posed a real problem to its suppliers. Neither ink manufacturers nor papermakers could predict what was suitable for the industry because no two press requirements were the same.

PRESS BLANKETS

Blanket manufacturers were also limited in materials suitable for the lithographic process. Natural rubber swelled or embossed badly in image areas, and developed tackiness and glaze in the nonimage areas. All of these conditions were further aggravated by the improper selection of ink diluents, and by a lack of knowledge in the selection of solvents for blanket washes.

The traditional wove paper surfaces allowed the pressman a broader latitude in blanket condition, but coated papers increased the degree of difficulty experienced under these blanket conditions.

The smoother surface of coated paper, when pressed into intimate contact with a "slick" blanket surface, failed to release easily after impression. Tacky blanket surfaces, of course, released poorly. Either condition aggravated the hazards of hooking, curling, waffling, splitting, and picking.

Embossed blanket surfaces created a condition of uneven impression pressures which could be tolerated to a much greater degree on wove paper surfaces than was allowable on

coated paper. The increased printing fidelity of a coated paper made image distortion much more apparent.

By the same token, pinholes and other blanket surface imperfections were more noticeable on coated paper and harder to compensate. It was more difficult for pressmen to makeready.

PLATE GRAIN

Those familiar with the requirements of the lithographic process in the early thirties will certainly remember the pressman's insistance on coarse-grained metal. A very coarse, deep grain was preferred, even for fine line and halftone work, and when large solids were printed, even coarser grains were deemed necessary. These coarse-grained plate surfaces added to the difficulties of printing coated papers by offset lithography, and on four important counts:

1. First, the coarse, deep grain carried a river of water down through the system to the paper. Apparently, this heavy flow of water was necessary because of poor plate surface desensitization; but when this excessive moisture transferred to the hard-sized coated papers of this period, it was decidedly disadvantageous. Expansion and curl made register and delivery difficult.

2. Second, these coarse grains were difficult to cover with surface coatings. Exposure of the thick coatings was erratic, especially in unconditioned pressrooms. Platemen resorted to liberal applications of ammonia, elbow grease, and wool flannel in developing operations. Such plate surfaces were incapable of holding a uniform ink film, and therefore, were incapable of printing a uniform ink coverage. Wove papers can be forced with ink and pressure to obscure partially such plate deficiencies, but the higher printing fidelity of coated surfaces reproduced the plate more accurately and, thereby, accentuated its deficiencies.

Pressmen observed this condition as evidence that coated papers would not cover properly—that they were hard to print with solid lays of ink.

3. Third, halftones printed down on a coarse-grained plate surface suffer severely in dot structure. Lithographers expressed disappointment. The improvement they expected from coated paper was not evident. The broken dots did look worse when they were reproduced more accurately on coated paper.

4. And fourth, the "home doctored" inks had a tendency to emulsify excessively in the flood of water required to keep them printing clean on poorly desensitized metal. These emulsified inks printed gray and washy. They further aggravated the pressman by drying poorly and chalking badly.

HALFTONE PICTURE

Halftone pictures in black and white further disappointed the lithographer when printed on coated paper because the pictures looked flat. One reason they looked flat and washed out was because the halftones contained large shadow dots. The reason they contained large shadow dots was because they were made to print on the traditional wove papers which required open shadow detail. Litho cameramen had yet to learn that the higher printing fidelity of coated papers required a different type of halftone to bring out the best in what coated surfaces had to offer the industry.

PRESS ADJUSTMENTS

Litho pressmen also found coated papers more difficult to run because they required new techniques in press makeready. The smoother surface of coated papers required more accurate feeder adjustments. Static influences were more pronounced. Friction drives on feeders required care and more careful adjustment. Grippers had to be serviced and set more accurately. Coated papers had to be delivered and jogged more carefully.

All of these requirements were well within the limits of the equipment available at the time, but pressmen were unfamiliar with them, and so they found it more difficult to run coated paper.

From where we stand today, we can see very clearly the progress the industry has made in the last 15 or 20 years. During the period of rapid technical development, the hand of progress has touched every phase of the lithographic process.

For instance, none will deny the progress that has been made in lithographic inks, and especially lithographic inks that are more adaptable to coated paper surfaces.

The function of fountain solutions and their ingredients are better understood, and formulations have become largely standardized in the industry. The days of stale beer, tobacco juice, and Mother Sills Seasick remedy are largely behind us!

Press blankets have been improved in their resistance to embossing, and their resistance to tackiness and glazing. Blanket surfaces are now available that cut suction to a minimum when smooth surfaces are released from impression.

Plate grains have grown finer and finer, until they now disappear entirely on the new multimetal plates and on the new zinc plates developed at the Lithographic Technical Foundation.

Better desensitized surfaces cut water feed to a minimum, and plate images don't go blind—they don't even get nearsighted any more.

Lithographic cameramen have learned to take advantage of finer plate grain, and higher printing fidelity coated paper surfaces, by making halftone pictures with longer tone range and more contrast and sparkle.

All of these things have helped the lithographic industry take advantage of the ever-broadening market for fine printing on coated paper surfaces. But, as I said previously, of equal importance in this progress has been the improvements in the coated papers themselves.

Part II

F. H. FROST

Mr. Reynolds has touched on the factors that led to the development of coated two side papers for offset lithography during the past two decades. I would like to add a footnote to his remarks.

The development was delayed, from the papermakers' point of view, by the concept that offset lithography existed as an important segment of the graphic arts because of its ability to print rough surfaces which were basically inexpensive surfaces. Why, therefore, coat paper thereby making it more costly, and remove the primary advantage the process possessed?

It was that false premise that delayed the development of coated two side papers by the paper producers.

As soon as it was appreciated that offset lithography was in itself a basic type of printing capable of producing results of the highest quality on smooth surfaces, special coated two-side papers were introduced to the trade for general commercial printing. You are all aware how fast this type of product has grown in popularity and the marvelous quality results which today are the rule rather than the exception.

I have had the pleasure of being associated with the development of coated two-side papers, as well as semicoated papers, since the inception of the utility for such products and propose to draw on that personal experience in the discussion to follow.

The idea behind coating a body stock is to provide an evenly absorptive continuous layer of pigment (such as clay) and adhesive (such as casein) which completely buries the fibers with the primary view of obtaining sharper, more uniform halftone dots. This concept applies equally well to offset lithography or to letterpress.

F. H. Frost, Research Director, S. D. Warren Co., Cumberland Mills, Me.

However, due to basic differences between these two methods of printing it was necessary to build special features in the coated offset paper.

Let's look at these features starting with the base paper and working outward to the coating.

First because the adhesion between the blanket and the paper is high, extra cohesive strength must be built into the fibrous mat in order to avoid the base from splitting when the paper is pulled away from the blanket.

This adhesion may be a paper surface-ink-blanket surface bond or a paper surface-water blanket surface bond. I have seen cases of base stock splitting on *unprinted* areas when no splitting occurred in printed areas.

The need for increased cohesive strength in the base paper has led to extensive research on the characteristics of different botanical types of fibers, different cooking procedures, fiber bonding agents, beating techniques, effect of different fillers—in fact a study of all the known variables which affect this cohesive strength.

Likewise various testing devices have been developed to measure fiber base cohesive strength.

Much progress has been made and established products rarely give trouble in splitting today unless the conditions on the press are unusually severe.

Tail-end hook and reverse embossing or waffling are closely allied problems and improvements have been made by the same techniques.

The problem of developing a strong internal cohesive bond is complicated by the fact that in the offset process water is transferred both to the printed areas—due to ink emulsification—and unprinted areas of the sheet.

This calls for the second essential feature, good stability against stretch and expansion due to moisture.

Such is easy to obtain by itself by simply reducing the degree of beating—a procedure which if followed will increase the tendency of a sheet to split, hook, and waffle. These two requirements work against each other and add serious complications.

During the war in our work on a special extra durable paper for army maps it was demonstrated that excellent strength and dimensional stability could be obtained by the incorporation of wet-strength resins in the fiber furnish and this is a perfect solution except for one fatal fault—it costs too much.

Hence the heart of the problem has been to produce both stability and internal strength at the same time. The paper industry has made fine progress but I believe there are still further and significant improvements to be made in the relatively near future.

The coatings themselves for lithography also usually require special properties.

First the bond between the coating and the body stock must be increased to withstand the increased tack of the inks normally used and, second, the internal cohesive strength of the coating must be raised for the same reason.

Again these are simple changes to encompass if considered alone but the usual procedure of increasing the ratio of adhesive to pigment reduces levelness of the surface, finish, ink affinity both as to lay of ink as well as increases offset tendencies, decreases opacity, brightness, and smooth folding characteristics.

Because of this, much work was required to produce adequate coating strength without impairing other features. Double coating, an effective means to accomplish this, was developed for such purposes.

Another important development was to develop a surface which would be relatively impervious to water yet retain the correct porosity to ink. This accomplishment has improved both the operation of the press as well as register because less water is required on the press and less is taken up by the paper without destroying the essential ink affinity required for the highest grade work.

The degree of insolubility required of a coating for offset lithography has, in my opinion, been exaggerated. It has been my experience little trouble arises from even quite soluble coatings in the lithographic process.

However such insolubility is fairly easily accomplished today—most coated offset papers have insoluble coatings.

The pH of the coating is an important variable since inks often contain emulsified water which can reduce the rate of drying of the ink. If you couple this with a low pH surface serious dry problems can result as the Lithographic Technical Foundation has repeatedly pointed out.

Another factor not involved in letterpress coated paper requirements revolves around the question of pigment from the coating building on the blanket and as it builds making frequent wash-ups necessary. This has been a tough problem to solve, especially in semicoated or surface filled papers but can be virtually eliminated in today's modern up-to-date products.

Still another requirement for coated offset papers is the necessity of maintaining a coating which will not release materials which may work back into the fountain and change the pH of the fountain solution or work back into the ink and effect either drying or emulsification.

As we see, the list is long and the requirements over and above that essential for letterpress printing are extensive. These have not been simple problems and much time and effort have been necessary to solve them but as a result of this effort the modern coated offset papers of today are a real advance over their prototypes of a few short years ago.

Offset Inks for Coated Papers

F. J. DANKERT

THE surface problems of coated papers in relation to lithographic inks is dependent upon the viscosity of these inks. The viscosity of an ink in general terms is its body, tack, and flow properties. A lithographic ink has to have certain characteristics of body to resist the fountain solutions used on the plate. It must at the same time have enough greasiness to be receptive to the image and have certain flow properties to carry or distribute on the roller. To this extent then I will try to explain the properties of lithographic inks with regards to their particular construction. At the same time I hope I may convey to you what the problems are in relation to a coated paper.

First, then, is the traditional linseed varnish ink. The principal factor here is the use of a variety of bodied oils. This type of ink has been used in lithography ever since its discovery by Senefelder. It has all the properties required for lithography in that it will distribute well on the rollers, has the necessary receptivity to the image, and will transfer readily from the rollers, plate, and blanket to paper. These inks are dependent upon metallic driers such as manganese, lead, and cobalt to obtain good drying on paper. There is a critical point of body for lithographic printing. If too soft it will emulsify more readily and thus cause a variety of problems on the press.

Next are the oleoresinous or semisynthetic inks. These are constructions composed of resinous materials reacted with linseed or other drying oils. They may be synthetically treated oils to improve drying properties. Inks of this type dry harder and usually faster. Thus, tack and body have to be watched as they tend to increase in body more rapidly than a conventional oil ink.

Next is the fast-set, quick-set, or redi-set inks. These inks are coming into use more and more. They are a combination of resin solvent and oil. These inks can be produced with a fairly low tack and quick absorption into a coated paper.

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Drying is obtained partially by absorption. Hence, less driers are necessary and there is a much more positive drying. This, because balance between resin and oil produce greater adhesion and bond to the sheet.

Heat-set inks are very much the same as the fast-setting inks. The difference is basically in the solvent ratio as well as the type of solvent used.

Gel-type ink is an ink of a jellylike body. They are full bodied, if we think of jelly being full, but are of fairly low tack. In effect, these are false body inks and are made that way by the addition of certain materials that swell the molecular structure of the varnish. These inks have certain advantages because of the low tack obtained with a fullness of body. They are, or can be, a combination of heat-set, fast-setting, and oil construction inks.

Gloss inks are constructions containing a high percentage of gloss varnish as part of the ink. These gloss resinous vehicles are usually quite viscous. Careful adjustments have to be made to avoid picking of the paper as well as piling on the press.

All these inks can and are being run on coated paper. Viscosity or body can be adjusted to fit a given stock. However, here a problem may arise due to the surface strength absorbency and receptivity of the stock itself. Naturally, many jobs may be run with an ink off the shelf, and the pressman will adjust the body for printing. If he runs into difficulty he will call on his inkmaker to advise him what to do. Or he may order it from his inkmaker if he wants such and such a color for a coated paper. He may refer to a specific paper, or he may not. An inkmaker knowing his customer generally is able to give him what is required. However, problems arise and do so because of many reasons.

What makes a good ink or a bad link is hard to define. But, in a general sense, I would say it is a matter of body or viscosity and tack. Viscosity and tack are related. How much? I don't know, nor do I wish to discuss the rheology of inks. I don't know enough about it. I do know that certain inks have more body and more tack than others and under certain conditions will produce good work. In this light then, let us examine these various constructions. As stated, linseed varnish ink is the old stand-by. In the years past, these inks were all of a stiff body and presses were slower and a good deal of time was spent in adjusting ink for a given job. Today, conditions have changed to high-speed presses with greater production as the goal.

From my experience straight linseed varnish construction has the highest tack reading on the Ink-Ometer. The oleo-resinous or semisynthetic inks are generally a little lower in tack. The fast-setting, quick-setting, heat-set, gel types and gloss inks are a good deal lower in tack. The poises in viscosity vary to greater or lesser degree along similar lines. If I should reduce the tack of a linseed ink to the same degree as was done with a gloss ink I might be able to print. But, the chances are I would have the problem of greasing and scumming, due to emulsification. If I got by with this I might have the problem of drying because of conditions of chalking and poor drying. Well under the same conditions why wouldn't gloss inks act the same? The reason why they don't and why there is no problem of drying is obvious. The gloss inks contain certain resinous binders which help both in drying as well as they have greater resistance to emulsification. It is because of this that a lower tack can be run and in fact is necessary to produce a good print. If this is the case why not make all litho inks, especially for coated papers, this way? I might answer that by saying I think the trend is toward such inks. Not as gloss inks, but as fast-setting, quick drying inks. There is no question that these inks have been an important advance in lithography. This type of ink differs from the straight linseed oil or the oleo-resinous ink in that a solvent is introduced as part of the varnish component. The use of solvents in litho inks is not new. There is many an old timer that has used petroleum distillates as dead oil, coal oil, or splash compounds. These were used to help reduce tack and to get an ink to lay smooth on a sheet. Their problem was to avoid chalking and poor drying. Today, however, this is not the problem as the drying of these inks is satisfactory. In fact, most of them can be handled a few hours after printing. In view of this what then are the problems involved with the use of such inks, and, second, is paper a factor? In the use of such inks, first consideration must be given to the rollers and blanket on the press. A great deal of improvements have been made with the synthetic rubber rollers and blankets to withstand the solvent action of these inks. Aside from this property, the other is the resiliency of the blanket which is required for good transfer. If these surfaces are too hard the transfer of ink is poor.

In like manner, what do we look for in a coated paper? There are undoubtedly many specifications regarding folding, tensile strength, surface strength, moisture resistance, etc. I don't begin to know the answers on these. In fact, I know very little about paper. My job is to make an ink run on a given stock and I will adjust the ink accordingly. In certain instances we will make a press run which gives us a chance to check both ink and paper. In others, we will make a pick test using Dennison's wax for this purpose. With a pick test of 9 to 10 or better we usually find no trouble. As you know, coated papers vary in their surface and some are more receptive than others. I find that this receptivity is tied in with absorption. In other words, a hard-sized sheet is not as receptive as a softer surface. Also, the hard-sized sheet will offset more readily in a pile which would require an adjustment in the body of the ink to make it penetrate faster. Thus, while we look for surface strength the absorbency is just as important.

This may be all academic to you and undoubtedly you gentlemen know more than I. However, as an inkmaker, I am concerned with good printing. I have tried to convey to you some idea of what an ink is composed of and its individual properties. We can make an ink less tacky and softer, but, I don't wish to convey the idea we can make them tackless. Some body or viscosity is necessary to work clean on the press. At high speeds this factor of viscosity is very important in that we hold the body and retain its resistance to water. Naturally, the paper's function is to stand up under the same conditions. I think this is being done generally as coated papers are being used more and more in lithography.

Offset Printing of Coated Papers

CHARLES F. KING

For years the offset lithographic industry took pride in its ability to print halftones, both in black and white and in color, on rough stocks. The softness of these prints was considered to be characteristic of the process, and lithographers made this one of their selling points. However, due to the economy and speed of the process, this type of printing soon began to compete for work which heretofore had been considered strictly in the realm of the letterpress printer. The lithographer stressed the fact that he could supply illustrations more cheaply than type matter, and the more illustrations there were to a form, the more reasonably he could produce the job. Furthermore he could use uncoated stocks and still give fine screen reproductions, thus instituting savings in paper.

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However, many printing buyers were disappointed in the jobs they had printed by "offset" and some to this day specify only letterpress printing regardless of cost. Technical difficulties with the process plus a great number of newcomers to the industry with inexperienced help were responsible for a large number of these disappointing jobs, but even when the jobs were well printed they lacked the "snap" which had been present in the original photographic copy, which buyers had been led to believe would be present in the reproduction.

This failure on the part of offset lithography to simulate the snap or contrast of a photographic glossy print was due at least in part to the type of paper which was used. Also, about this same time the popularity of color photography was growing. Whereas lithography was able to outshine relief printing in the reproduction of hand painted art subjects, art work which consisted of Kodachromes and other color photographs lacked that true photographic appearance when reproduced. In both color and black-and-white work, the letterpress printer was able to reproduce on coated paper illustrations which more closely adhered to the qualities of the photograph. The only alternative for the lithographer was to print on coated paper.

At this point there was very little factual information available concerning the offset lithographic process. Also, many operators of lithographic equipment were not able to produce uniformly good jobs even when they were well suited for reproduction on so-called offset paper. The swing to coated papers opened up a whole new Pandora's box of troubles for these latter printers, and there are some who, to this day, will not figure on a job which must be produced on coated papers. However, had the factual information been available, the paper industry would not have been forced to use that furnished by the lithographers in attempting to make stocks which would run satisfactorily on an offset press. Furthermore, the paper industry owes a great debt of gratitude to the chemists and service men from the printing ink industry. Actually it is the ink men who have stayed by the presses, often far into the night, attempting to make a stock run.

Perhaps this is a strange sort of a paper to present before a technical group, in that it lacks data, slides, and references such as are usually associated with such papers. However it is the purpose of this paper to bring to the attention of this group some facts and some theories concerning the offset lithographic process and how they affect or how they are affected by coating or coated paper. It is hoped that this information, most of which has been gathered in the pressroom, will aid those who understand the formulation of such coatings in producing improved sheets for lithography.

In considering the offset lithographic process, it is impossible to break it down and consider any one operation or any one material used as a separate entity. In laying ink on paper, everything from the art work to the dried film of ink on the paper must be considered. The need for coated paper in reproducing certain types of art work has already been considered in introducing the subject. However, of greatest importance to the papermaker is the performance of the stock on the press. This is affected by the nature of the process, the composition of the rollers, blankets, and ink, and the construction of the press itself. In addition, there is the great unknown, unmeasurable, and unpredictable factor, the pressman.

Although the process of making a plate which will take ink in the printing areas and will accept water and repel ink in the nonprinting areas is well understood, there is still much to be learned concerning what takes place on the press during the successive dampening, inking, printing to the blanket, and then to the paper operations. Apparently the water solution which is first applied to the plate is supposed to perform three functions: (1) it dampens the nonprinting areas so that they will not take ink, (2) it should restore any of the water receptive characteristics of these areas which may have been destroyed or damaged in the previous cycle, (3) a large portion of it should form an unstable emulsion with the ink and be taken up by the ink rollers as they pass over the water-wet areas of the plate. This emulsion must be a water-in-oil emulsion. Any water which is not taken up by the rollers is transferred to the blanket and thence to the paper.

The composition of the water solution is a question upon which there is little or no agreement. Attempts have been made to standardize the solutions on the basis of pH, but more recent findings seem to indicate that although pH will show how readily the metal may be attacked, it has little or no meaning as far as the ability of the solution to perform the three functions listed above. About the only general statement which can be made concerning these solutions is that they usually contain gum arabic and some or all of the following ions: dichromate, nitrate, ammonium, phosphate, magnesium, and/or zinc. Since the water wettable areas are made so through the use of gum, it may be presumed that it is necessary for the restoration or regeneration of these areas, but what role the other materials play in performing this function, together with the other two functions, is not known.

As can be seen from the above, the ink and the inking system perform a dual function. They must both feed ink to the plate and remove water from it. The more highly emulsified an ink is, the more buttery it becomes and it loses its ability to transfer from roll to roll and to the plate. This causes the print to appear gray and washed out. When the correct amount of the proper water fountain solution is carried for the proper ink, there will not be too much loss of tack to the ink, and the picked up water will evaporate from the ink on the distribution system. This will insure a continually fresh supply of ink with the correct transferring properties to the plate.

Any excess water which is not picked up into the ink is transferred in part to the rubber blanket at the same time as the ink. A portion of this water may then be transferred to the printing surface of the paper. The machine finished offset stocks absorb moisture quite readily, whereas many coated stocks do not.

However, this property of removing moisture from the blanket cannot be too important, since one of the earliest applications of offset lithography was printing on tin. It is obvious that tin does not absorb water. But tin is dissimilar from paper in one other property. It is strong enough to withstand the pull of the tackiest ink. If a very tacky ink is used, the nonprinting areas show less tendency to be wet by it, and a sharper transfer takes place between the form rollers and the plate. Also the effect of the water picked up by the rollers is not as great. Even though the tack is reduced, the reduction is in relationship to the original tack of the ink, and the working of a tackier ink in the distributing system of the press generates more heat which causes the water to evaporate more quickly.

Following the thinking of some lithographers that the answer to most of the problems encountered in running coated papers could be solved by using tackier inks, some mills have produced sheets so hard that they did not readily accept ink. The lithographer in turn would increase the tack of the ink still more in order to make the ink transfer better, only to find that the sheet needed to be still harder to prevent picking.

Again referring back to tin printing, when electrolytic tin plating took the place of hot dip methods during the war it was found that it was impossible to print on the new plate. After considerable experimentation and research it was found that in the hot dip method a thin film of palm oil covered the plating. The oil was not required in the electrolytic deposition, but without it the surface of the tin could not be wet with the lithographic ink. In the merry-go-round of increasing hardness and increasing tack of ink, the question of wet-

tability of the coating has frequently been disregarded just as it was in the case of the tin plate industry. Thus, although tack is an important factor in ink transfer, the ability of the surface to be wet by ink is equally or more important. Also, the ink wettability characteristics appear to be more directly related to trouble-free operation than water wettability or absorption.

Earlier in this paper such words as "proper" and "correct" were used to describe inks and fountain water solutions, and the ink-water relationship in the inking system. This was simply a rhetorical means of glossing over some very important factors for which there are no accurate means of determining. Thus their control, even to the final composition of the ink and the water solution, is often left to the complete discretion of the press operator, and hence is considered to be a part of pressmanship. However, his job has been made easier by the ink chemist who has been able to furnish him with materials which he can add to the ink to help control emulsification, and inks which do more readily wet the surface of the coated sheet. Today, many inks used in lithography are much softer and less tacky than those used in printing gloss inks on rotary letterpresses operating at the same or even higher surface speeds. Thus the problem is no longer one of chiefly making the sheet strong enough for lithography, but instead making a sheet that has a coating which has been designed especially for use on a lithographic press.

Years ago papermakers said, "Tell us what you want, and we will attempt to make it." At that time about all that could be told was that information which had been gathered from experience with uncoated sheets. Emphasis was laid upon the dimensional stability of the sheet; a coating with a pH value near 7; enough strength to prevent picking, splitting, and other mechanical failures in the sheet as it is pulled from the blanket; and an insoluble or nonreactive coating. Multicolor presses have to some extent lessened the demand for accurate control of dimensional stability, although wavy edges and full sheets still present problems. Also, paper is occasionally received which is so far out of condition from pressroom humidity that it will go out of register even between units on a four-color press. Generally speaking, these are the exceptional lots of stock rather than the usual ones.

The idea of trying to keep the acidity or alkalinity of the coating as near neutral as possible, has apparently been abandoned, and alkaline coatings seem to run just as well as those which are neutral. However, sheets are occasionally encountered even today which either have water-soluble binders or contain materials which do react with the water on the blanket. Some of these sheets cause the coating to pile on the blanket in the water-wet areas, whereas others are either softened by the first contact with the wet blanket or some material in the coating reacts with the acid in the water. In these later cases the piling takes place on succeeding blankets on the same press, or under certain conditions when the paper must go through the press a second time, on the blankets on the following press or presses.

Improvements in both inks and blankets, together with the pressman's experience in learning which blankets work best for coated paper and how to keep them in good condition, have practically eliminated any need for extra strength in offset coated papers. If the wax test means anything, and some claim that it does not, a stock which will withstand a no. 7 wax has ample strength. However, if the coating is affected by moisture, the test is meaningless.

One might assume up to this point that all of the earlier demands of the lithographer had been met. They have. The trouble is that they are not consistently met. Frequently four out of five sheets in a load will meet the demands perfectly, but the fifth sheet will require the press to be slowed from 5000 sheets an hour to 3000, or that fifth sheet will make it necessary to wash the blanket every few thousand sheets. To date there are no standard testing methods which will anticipate these troubles. Thus the problem of coated stocks for offset lithographic printing resolves itself into two problems: (1) controlling the factors which have long been known to be important, (2) determining and controlling the improvements which should be possible on the basis of a better understanding of the process.

Modern platemaking methods make possible the printing of sharper dots, and sharper type characters by offset than by any other method. The same idea that was behind the thinking that rough papers could be used, also accounts for this exceptionally sharp print on coated paper. The fact that the blanket conforms to the surface of the stock means that uniform coverage of ink can be attained with half the volume which would otherwise be required. Hence there is little or no tendency to squash the print, and give it the appearance so typical of letterpress. However, when a coating is not wetted easily by ink, it is necessary to depend on the pressure between the blanket and the paper and the tack of the ink to effect good transfer. Both the plate and the blanket must be crowded with ink to print full color. Crowding the plate means that more water must be carried to keep the plate clean and more water is on the blanket at the time the sheet is printed. Also more water means that part of the tack of the ink is lost and good transfer is reduced. This has been the cause of the merry-go-round when harder and harder coatings were attempted.

Some coatings available today are fairly easily wet with ink and others although not quite so easily wet do have the ability to remove rather large quantities of ink from the blanket by rapid absorption. Such coatings do not need to have so much strength of bond, since softer inks can be used with a minimum of pressure. Due to the continual transferring of rather large volumes of ink (comparatively speaking) to the paper, fresh ink is continually being fed through the inking system and this contains a minimum of water. Also the blanket is practically free from water and there is less tendency for the sheet to be distorted, and also less for it to adhere to the blanket in the nonprinting areas. In this manner many of the problems inherent in running coated papers are reduced in severity.

Although the foregoing discussion may sound theoretical, and wettability by ink has been used, for the most part, instead of absorption of the ink into the coating, a recently performed experiment appears to confirm this idea of the importance of wettability. A regular varnishing grade coated stock was coated with a lacquer-type finish. This finish was applied on a varnishing machine and dried by evaporation. It dried with a high gloss, and could be wetted by but was not soluble in the vehicle portion of standard (if there are such things) lithographic inks. This stock was then placed in the feeder of a four-color press which was running this same grade of casein-coated varnishing grade paper. With no alterations in press adjustments the ink transfer improved as this stock was run. In order to carry the same intensity of color as had been carried, it was necessary to continually reduce the flow of ink from the fountain.

It was apparent that there was no penetration of lacquer film, since although these inks were not gloss inks, they dried with a finish higher than is normally attained with gloss inks. Furthermore, the sharpness of the printed tones was far greater on these lacquered sheets than it had been on the casein coating.

This particular lacquer was selected because of its ability to be wet by ink. It had previously been used on jobs which were to be imprinted with customers' designations after the jobs had been delivered. It was a commercial product and its resin composition is not known. However, in addition to printing well, it gave no trouble from offset (a dry spray was used) in spite of the fact that the ink did not penetrate the stock. Further experiments were carried on by pigmenting the lacquer with white pigments and a beautiful sheet resulted.

In conclusion, although most of the previously recognized properties needed in a good offset coated sheet are important, that of wettability of the surface by ink rather than absorption of ink into the stock is extremely important. Up to this point most improvements in wettability have been made by the inkmakers, but it appears that improved wettability could be incorporated into the coating itself.

Nonpaper Factors and Quality of Offset Lithography

DAVID W. S. RIDDELL

In offset lithography more than any other graphic arts process one encounters innumerable variables. The purpose of this paper is to dwell briefly on some of these factors which are unique to the process, and to mention some of the work being done to enable the lithographer to better control the quality of his finished product.

I have broken down the offset lithographic process into three main divisions: camera, plate making, and press. Camera variables in lithography are not unique to that process, but are shared with photoengraving, gravure, collotype, and to some extent with xerography and silkscreen.

It is in the plate making and press work that offset lithography comes into its own as a graphic arts medium vastly different from the other major printing processes.

When one refers to a litho plate, it is usually without considering that there are today over a dozen different types of litho plates being used, and five in common usage.

The five broad types of litho plates most commonly made today are deep-etch, albumen or surface type, presensitized which is actually usually a surface type plate, bimetal, and hand transfer. The last mentioned is the only one which is not a photo plate.

The vast majority of all offset lithography in North America utilizes either deep-etch or surface type plates on either zinc or aluminum, usually grained. Although generally speaking the processing and handling of these two different metals are similar, the chemical and physical properties of aluminum necessitate somewhat different techniques being used, particularly in its treatment on the press. In the case of either metal, grain has a profound effect on the printing quality of any plate. I will discuss the grain factor in more detail under press or printing factors, but it is well to mention it at this point, as grain affects several factors in plate making.

For the benefit of any who may not be familiar with litho plate making and the differences between a deep-etch and albumen or surface type plate I'll briefly outline each process, and for the sake of simplicity will assume a grained zinc plate is used.

The steps to be followed to make an albumen or surface type plate are:

1. Counter etching (treating with a dilute acid).
2. Coating (in a whirler with bichromated albumen or similar colloid).
3. Exposing (in a vacuum frame through a negative).
4. Covering with a developing ink.
5. Washing with water to remove the ink and unhardened colloid from the nonimage areas.
6. Etching (applying an acidified hydrophylic gum to the nonimage areas).
7. Gumming with gum arabic.

The making of a deep-etch type of plate is somewhat more complex, but this process lends itself to a certain amount of tone control during processing.

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The steps are:

1. Counter etching (same as for a surface plate).
2. Coating (usually with a bichromated gum solution).
3. Exposing (through a positive in a vacuum frame).
4. Developing (with a high S.G. mildly acidic salt solution usually $CaCl_2$ about 1.36 S.G.).
5. Deep etching.
6. Washing with anhydrous alcohol.
7. Lacquering.
8. Applying developing ink.
9. Scrubbing off stencil with warm water.
10. Etching and gumming as in the making of a surface type plate.

There are four major variables in plate making which require control if consistent quality results are to be obtained. These are:

1. Consistent quality and composition of all chemicals entering into the process.
2. Relative humidity of the work area.
3. Temperature of the work area, water used, and processing chemicals.
4. Exposure. Time alone is sufficient control of exposure providing modern motor-driven carbon arcs are used, however, where solenoid actuated-type arcs are used as a light source, some form of light integrating device is a necessity for accurate exposure control. As bichromated colloids have their peak sensitivity in the blue and ultraviolet region of the spectrum, quantity of light used in exposure is not sufficient control, but spectral quality is an important consideration.

Relative humidity and temperature have a profound effect on the rate of hardening by light of bichromated colloids, as well as influencing the rates of dark reaction (hardening away from light, before exposure) and continuing reaction (hardening in the absence of light, after exposure). Jorgensen of the Lithographic Technical Foundation has done much valuable work investigating these factors.

Jorgensen's findings show that when a sensitized litho plate is refrigerated to about 40°F. both dark and continuing reactions are virtually halted, enabling a plate to be stored for weeks with no appreciable change in sensitivity.

The aforementioned variables are but a few of the major ones encountered in litho plate making. Several years ago at the Lithographic Technical Foundation, a small group in the lab, while having a bull session, decided to list all the variables in litho plate making. In about 15 min. we had written down 43. I am sure that our list was incomplete, in fact, I believe that we are working with variables which we don't even know exist.

Press factors which affect the quality of offset lithography are probably better understood than other variables, but just as difficult to control. Excluding the paper factor, which is in itself a tremendous variable, the major factors with which a pressman must cope are:

1. Type and quality of plate.
2. Pressures and packing.
3. Blanket condition and hardness.
4. Fountain solution and condition of dampening system.
5. Ink, relationship to plate, blanket, and paper.
6. Actual mechanical condition of press.
7. Type of press with respect to job.

Although this paper deals primarily with nonpaper factors, it is virtually impossible to discuss other printing variables without occasionally mentioning paper.

I previously mentioned that the bulk of offset lithography today is produced from grained zinc or aluminum plates. At this time I would like to digress momentarily from press factors and discuss lithographic grains. It has often been asked, "What constitutes a good grain?" To date I have not heard an all-inclusive satisfactory answer. So much depends on amount of ink coverage, type of work, fineness of screen in halftone printing, etc. At present it would seem that grain is a necessary evil, although recently some excellent work has been done on smooth plates. The chief difficulty encountered

in running a smooth plate is controlling amount of moisture. A radically changed dampening system could open up new fields for grainless plates and possibly eliminate many of today's printing variables.

So far we are unable to accurately and comprehensively measure grain. A few of the techniques tried are surface roughness testers of the Brush instrument type, microscopic examination with a depth measuring microscope, rate of escape of air through grain valleys, sorption of phosphoric acid containing a tracer of radioactive phosphorus, contact angle measurements, and diffuseness of a cast cellulose acetate mold of the grain. This work has been conducted by the Lithographic Technical Foundation and a great many independent observers.

At present, grain is produced by three different methods, the first and the one in most common usage, is by marbles, usually steel, abrasive, and water, in a tub having what might best be described as a rotary oscillating motion. Grain is also produced chemically or electrochemically, and by abrasive blasting.

A few of the factors which affect the quality of a tub-grained litho plate are:

1. Marble load and size distribution.
2. Type and amount of abrasive used.
3. Amount of lubricant (water or dichromate solution).
4. Speed of rotation.
5. Time.

John Markward, formerly sponsored at the Lithographic Technical Foundation, conducted an intensive survey of lithographic grains, and has set up schedules to be followed to obtain "fine, medium, and coarse" grains on both zinc and aluminum. The results of his work are published in the Lithographic Technical Foundation's research bulletin no. 17, "The Standardization of Graining Procedures."

Generally speaking a grain to be suitable for lithography should be matte and free from scratches in appearance, the peaks should be close together, and the valleys deep. It has been theorized that a grain having a large micro area to macro area ratio will be the easiest to run on the press.

Some of the results of too coarse a grain are mealy appearing halftones, and loss of fine detail, mottled solids, and a tendency toward scum and catching up if the plate is not perpetually flooded with water. This condition is contrary to common belief that optimum results are obtained from minimum ink, minimum water. The reverse condition of too fine a grain causes difficulty in that amount of fountain solution run must be controlled to such a fine point, that dampeners rapidly get dirty, thus quality is degraded unless dampeners are changed at least daily and under a few isolated sets of conditions changed after every 10 or 15,000 impressions.

The type of plate being run has a great potential effect on the quality of a lithographed job. Fountain solutions must be adjusted to suit the plate metal, type of plate, paper, ink, etc. It is virtually impossible to set up a fountain solution formula which will work well for all sets of conditions.

Generally speaking a fountain solution consists of a dilute aqueous gum arabic or C.M.C. solution acidified to a pH value of 4.0 to 6.0, often containing traces of inorganic salts. Very little concise scientific information is available on fountain solutions, and their precise action is not too well known.

Press packing and pressures are factors which have undergone much investigation, and their relationship to finished print quality is understood in most quarters. Numerous publications are available from press manufacturers as well as several nonprofit research organizations, setting up correct packing procedures to be followed to obtain optimum print quality. On occasions, however, it is impossible to adhere rigidly to optimum packing specifications. With some lightweight stocks, packing and cylinder diameters must be juggled to enable a job to be satisfactorily printed. With multicolor lithographing on paper, packing must be varied from color to color to allow for size change in stock, and still maintain register.

Blankets for offset lithography are available in several degrees of resiliency. The difference between a "hard" and "soft" blanket is slight, but sufficient to facilitate printing fine screens with a hard blanket, or large solids with a soft blanket.

Prior to the advent of the modern synthetic blankets lithographers were plagued with surface oxidation or ozone degradation of the rubber bringing about a tacky condition. This feature is almost nonexistent in synthetic blankets, but even these may become somewhat tacky without proper precautions being taken to preserve a soft matte tack-free surface. Certain types of inks show a marked tendency to swell or emboss the blanket, giving nonuniform, printing pressure. I refer particularly to rapid setting, solvent-type inks. Although generally speaking the solvents used in these inks have a low kauri butanol value, they are capable of swelling many synthetic rubbers. Periodically changing blankets and allowing them to "rest" seems to alleviate this condition.

Litho inks are in themselves a tremendous factor quality wise. Inks are a subject on which much has been said and written, and I don't feel qualified to delve into to any great depth. Suffice it to say that all reliable ink manufacturers maintain excellent technical personnel, and it is the wise lithographer that keeps in close contact with his ink manufacturer's technical staff. Tremendous technological advances have been made in ink manufacturing during the past quarter century.

Maintaining presses in top notch mechanical condition is a point which cannot be overemphasized. Without modern press equipment in good condition, a lithographer can't expect to produce quality work. Many of the industry's problems today are due to poor maintenance programs. A few of the symptoms of a mechanically defunct press are misregister, nonuniformity of print, slur, roller, and/or gear streaks.

Not all lithographic presses are suitable for any given type of work. Some machines have been designed for the sole purpose of producing single color noncritical register work, at high speeds. Other presses are designed to print multicolor close register work.

Summing up it can be seen that the offset lithographing industry is one which technologically is still in its infancy. Since the turn of the century lithographers have seen an art medium grow into a highly mechanized mass production industry. I believe that much of our learning has been based on unsound technology, but we appear to be gradually emerging from the dark ages, possibly more fittingly called the "Stone Age." If research and application of scientific reasoning continue to grow as they have in the past 25 or 30 years, lithographers can look forward to a bright future.

Operating Factors in Offset Printing on Coated Papers

ROBERT F. REED and GORDON WHEELER

The increasing use of coated and enamel papers by offset lithographers during recent years has focused attention on problems of precision and control that were not particularly evident in the printing of uncoated stocks. In spite of these problems, coated papers are being used because they improve reproduction. Blacks are blacker, and colors have increased purity and intensity.

The paper mills, in general, have succeeded in making coated papers that meet the special requirements of surface strength, moisture resistance, and chemical inertness for

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offset printing. Therefore, assuming that the paper is good, the problem of the lithographer is largely one of adapting his press conditions and printing technique to produce a suitable ink impression on the smooth, coated surface. This involves a higher degree of precision and control in press adjustments and settings than for uncoated papers, and also the selection of suitable rollers, blanket, plate, fountain water, and ink.

PRESS FACTORS

All offset presses are built to a high degree of mechanical precision. However, different makes of presses differ in the weight and rigidity of elements, and therefore in their ability to maintain pressure settings. No one knows exactly what the pressures are since they are set in terms of thousandths of an inch, but it is obvious that they depend on rigidity of the press elements. As a result of constant use, the journals and gears are subject to wear which, of course, reduces the precision of settings and introduces opportunities for variations in the angular velocity of the cylinders which should be absolutely uniform for high quality printing. When such variations reach sufficient magnitude, they result in the printing of scum streaks, often called gear streaks but not necessarily related to the gears.

Since the same amount of ink prints with a higher density on coated than on uncoated paper, any scum that may be printed on areas that should be clean is more visible than on uncoated paper. Also a press that is doing a satisfactory job on uncoated paper may print streaks on coated paper. This merely indicates the need for a recheck of press settings and possibly an overhaul job. Coated paper requires greater precision in printing than uncoated.

Scum Streaks

Scum streaks parallel to the cylinder axis are of several kinds. Parallel streaks having the same pitch as the gear teeth are true gear streaks caused by variations in angular velocity due to wear of the gears. Sometimes they can be eliminated by increasing the bearer pressure or by transferring packing from the blanket to the plate cylinder. But if the press is to give good service under all conditions, the gears should be replaced.

When the parallel streaks have a pitch greater than that of the gear teeth, the trouble is most likely either a loose and slipping blanket, worn and chattering cylinder bearings, or excessive emulsification of ink in the fountain water. Simply tightening the blanket should eliminate the first cause. If cleaning the dampening system and stiffening the ink do not help, new cylinder bearings may be needed.

In a third case there may be only a single streak. This may be due to end play in one of the form ink rollers that allows it to shift endwise with the change in direction of its vibrating drum, producing a severe rubbing action on the plate. The form rollers should have no appreciable end play.

A fourth type of scum streak occurs at or near the gripper edge of the sheet. This is usually caused by form rollers or dampening rollers that are set too hard against the plate. They bump or bounce as they pass from gap onto the the plate, causing severe abrasion.

Scum streaks extending around the cylinder are usually caused by greasy dampening rollers. The more greasy areas fail to transfer sufficient moisture to the plate. Clean, water-receptive dampening rollers are essential to clean printing, particularly on coated paper.

The most difficult form to print is one containing large uniform halftone areas. Streaks may appear in these areas when there is no evidence of scum in adjacent white areas, but their causes are exactly the same as for the scum streaks just described. Such streaks are always more pronounced on coated than on uncoated paper. The printing of a large uniform halftone area is an excellent test for the condition of a press.

The Offset Impression

In offset printing there are two lines of impression: one between the plate and blanket cylinders, and the other between the blanket cylinder and the paper which is backed up by the impression cylinder. The pressure necessary to transfer the ink in both cases is obtained by depressing the resilient blanket surface. For good printing, especially on coated paper, this pressure must be precise and uniform.

To attain this it is obvious that the cylinders must be properly aligned and true, not warped or dented. Assuming that these conditions have been met, the things that limit precision in the impression are variations in the thickness of the plate, blanket, and packing sheets. Since large plates and blankets can vary as much as 0.002 in. in thickness from one area to another, it is possible for the impression between the two to vary as much as 0.004 in.

Experience has shown that a range of about 0.002 to 0.004 in. of impression is best for quality reproduction. Less pressure than 0.002 in. fails to transfer ink properly, and more than 0.004 in. tends to distort or thicken the image transferred to the blanket. If variations in either or both the plate and blanket thickness produce pressures outside this range, the printing will not be uniform. It is then up to the pressman to makeready by adjusting the packing to attain the necessary precision. For coated papers this is particularly important since the effect of pressure variations is more noticeable than on uncoated papers.

Uniformity of impression from the blanket to the paper is particularly important. Variations affect the transfer of ink and the solidity of the printed impression. Also, if normal pressure is exceeded, the impression will be thickened or slurred. Slurring seldom occurs on uncoated papers because their rough surface provides good blanket traction. But the smooth surface of coated stock together with the lubricating action of the ink promotes a slippage in the impression that result in tails on the larger halftone dots and a slur at the back edge of solids. Only precise and uniform blanket-to-paper impression will avoid slur in printing coated paper. Embossed areas on a blanket from a previous printing will sometimes produce enough excess pressure to cause slurring. Such a blanket should be discarded or saved for printing on uncoated paper.

PRINTING PLATES

Coated papers are often blamed by the pressman for causing the printing plate to scum. Careful studies of coated papers and press operation show justification for this in the following cases:

1. The paper carries abrasive surface dust that accumulates on the nonprinting areas of the blanket and wears off the desensitizing film on the plate.
2. The paper surface carries particles of coating and/or fibers that accumulate on the printing areas of the blanket and plate, necessitating frequent wash-ups. Too many wash-ups will sensitize the plate and cause scumming.
3. The coating contains a water-soluble surface-active material that lowers the surface tension of the fountain water causing it to emulsify the ink. This condition is aggravated if the pressman uses a wetting agent in the fountain water.
4. The paper has a tendency to pick so that the pressman has to soften his ink unduly. This lowers the ink's resistance to water and increases its tendency to sensitize the plate.

Cases 1, 2, and 4 also occur with some uncoated papers, but scumming or tinting is noticed sooner and is more objectionable on coated papers.

There is no evidence that the coating pH has any relation to scumming. Coatings from pH 6.0 to 10.0 are being printed without any scumming trouble.

The newer methods of desensitizing printing plates eliminate much of the trouble in printing coated papers. These methods include post treatments that remove all colloidal residues from the nonprinting areas, the use of cellulose gum

desensitizing etches, and drying down of the etch before gumming up the plates. Plates made by these methods require less moisture in printing and yield sharper and denser ink impressions than plates not so well desensitized. This is true also of bimetal plates. Much of the current success in printing long runs on coated paper is due to these developments. However, with coatings that are lacking in moisture resistance, the reduced plate moisture may promote piling of coating pigment on the nonprinting areas of the offset blanket. The pigment may also accumulate in the ink, and, being abrasive, it may damage the printing areas of the plate. Adequate moisture resistance of coatings is therefore highly important.

FOUNTAIN WATER

From what is known of the chemistry of lithographic printing there seems to be no reason for using anything but tap water in the press water fountain. Experience, however, indicates the need for a low concentration of certain salts, acids, and gum. Chemically, the functions of these materials are not known with any degree of certainty. Research in this field is especially difficult since there are no criteria known except actual press runs upon which dependable conclusions can be based.

The primary purpose of the fountain water is to maintain a moisture film on the nonimage areas of the plate to act as a barrier and prevent these areas from being wet by the ink. This is the basic principle of lithography. Chemicals and gums are put in the fountain water to keep the nonimage areas from gradually becoming ink receptive during the run and to prevent the dampening rollers from becoming fouled with ink. With a well-desensitized plate, printing can be done for a time with distilled or tap water alone, but sooner or later something has to be added to prevent the development of scum. In practice, therefore, the pressman usually has a concentrated mixture, or fountain etch, of which he adds 1 or 2 oz. to a gallon of fountain water.

Formulas for fountain etches have been developed by purely cut-and-try methods. A wide variety of chemicals and combinations have been tried, usually without any guidance from theory. Gradually, the field has been narrowed down to a relatively few ingredients, which include

Sodium, potassium, and ammonium phosphates
Sodium, potassium, ammonium, calcium, magnesium, and zinc nitrates
Chromic acid and sodium or ammonium bichromate
Phosphoric acid
Gum arabic and carboxymethylcellulose

A single material is hardly ever used and a typical fountain etch formula for zinc plates is as follows:

Water	3.0 qt.
Sodium bichromate	32 g.
Ammonium phosphate, dibasic	30 g.
Zinc nitrate	800 g.
Phosphoric acid, 85%	78.5 g.
Water to make	1 gal.

When 1 oz. of this mixture and 1 fluid oz. of 26% gum arabic solution are added to a gallon of distilled water to produce the press fountain solution, the pH value is about 3.4 and the calculated ionic composition is shown in Table I. (Using Chicago tap water instead of distilled water, the final pH value is about 5.3.)

Table I. Concentrations of Ions

Ion	*In concentrate, g./gal.*	*In fountain solution*		
		G./gal.	*G./liter*	*Ionic conc.*
Na^+	4.93	0.038	0.0100	0.00043
NH_4^+	8.20	0.064	0.0169	0.00094
Zn^{++}	175.0	1.367	0.3610	0.00555
$Cr_2O_7^{--}$	23.2	0.181	0.0467	0.00022
PO_4^{---}	86.3	0.674	0.1739	0.00183
NO_3^-	333.0	2.60	0.6870	0.01110
Gum arabic	...	8.5	2.2	...

For aluminum and bimetal plates the formula is usually different, but this will serve as an example.

The only thing science has done for the fountain water has been to introduce pH control, but pH is significant only with respect to a particular fountain etch formula. For practical reasons the pH is varied depending on such variables as paper, ink, coverage of the form, and temperature. Principally, pH control gives the pressman some idea of what he is doing and helps him avoid acidity that might be damaging to the plate.

Side Effects of the Fountain Water

If the effects of the fountain water were confined to the printing plate, its problems would be greatly simplified. Unfortunately, part of it is picked up by the ink rollers, and part is transferred to the offset blanket and thence to the paper.

The part that goes to the paper can, if excessive, cause curling and dimensional changes, the latter resulting in misregister. Also, in multicolor printing on paper that is insufficiently water absorbent, water applied to the paper surface in printing the first color may not be completely absorbed before the sheet receives the second color. This surface moisture, then, can act as a barrier to the second ink, preventing it from contacting the paper and producing a uniform impression.

We have been told that the Swedish Graphic Arts Research Laboratory in Stockholm has set a specification for the surface wettability of offset paper, namely, that its contact angle with water must not be less than 90°. The object is to prevent, as far as possible, dimensional changes due to moisture absorption. No doubt there is some relationship between surface wettability and the amount of moisture taken up by the paper. But it is also true that even a little moisture, if not quickly absorbed by the paper, can act as a barrier and prevent proper reception of the second ink in multicolor printing. It seems, therefore, that an upper limit to the contact angle or a minimum value for water absorbency of offset paper should also be specified. Actually, it is doubtful if contact angle measurements help very much in controlling paper expansion during offset printing. With good plates that the pressman can run with a minimum of moisture, there is actually no expansion problem even with very slack-sized and absorbent papers.

The part of the plate moisture that is picked up by the ink rollers quickly forms a water-in-ink emulsion. Many inks can take up 25 to 30% of water. This emulsified water has some detrimental effects:

1. It dilutes and weakens the ink.
2. In some cases it makes the ink short and buttery and prevents proper transfer, with the result that the ink tends to pile.
3. The moisture, and particularly the chemicals dissolved in it, retard drying of the ink.

All of these bad effects are minimized, of course, by cutting down the amount of dampening water fed to the plate. This is where the improved surface and deep-etch plates previously mentioned, and bimetal plates, help since they require less moisture and less "acid" than plates made by the older methods. But the bad effects still exist to some degree.

Some preliminary research has been done by the Graphic Arts Research Laboratory in Stockholm* and by PATRA† on the effects of acids and salts in the fountain water in retarding the drying of inks. In both cases the individual materials were studied, rather than mixtures commonly used, and in both cases it was found that phosphate strongly retarded the drying. However, in the Swedish work, concen-

* "Chemical Aspects of Ink Drying," G. E. Carlsson and L. Pihl, *International Bulletin for the Printing and Allied Trades*, July, 1952.
† "The Inhibition of Drying of Lithographic Varnishes by Acid and Salt Solutions," R. R. Coupe, *ibid.*

F. S. Dankert, Sun Chemical Co.; D. W. S. Riddell, The Montreal Lithographing Co., Ltd.; C. F. King, U. S. Printing and Lithograph Co.; F. H. Frost, S. D. Warren Co.; R. F. Reed, Lithographic Technical Foundation; and A. C. Zettlemoyer, National Printing Ink Research Institute

trations of 2 grams per liter were used which is about ten times the concentration of phosphate shown in Table I for a typical fountain solution. In the British work, the phosphate solutions used had a molar concentration of phosphate radical of from 0.03 to 0.10 compared with 0.00187 in the fountain solution analyzed in Table I. Also, the British work was done with lithographic varnishes containing 0.0314% cobalt, whereas a black lithographic ink normally requires from 0.15 to 0.20% cobalt for proper drying. It is altogether probable that these conditions yielded exaggerated results far from representing normal printing conditions. It is also probable that combinations of phosphate with chromate and/or nitrate would yield quite different results.

Practical experience has evolved mixtures of phosphates with either chromates or nitrates or both as most effective in keeping the plate clean in printing. Scientific research is particularly difficult in this field because of the many factors involved, and because no known laboratory tests can predict what will happen in a long press run. Nevertheless, there is need for fountain solutions for the different types of plates that are based on sound scientific knowledge.

Retardation of drying of the ink by the fountain solution is more harmful on coated than on uncoated papers. This is because the strongly oil-absorbent coating drains vehicle from the ink film and causes chalking if the drying time is prolonged. The use of a minimum of dampening water with a minimum concentration of negative ions is especially important in printing coated papers.

INK

Inkmaking is an art based largely on cut-and-try experimentation. This is not a criticism. Science has only begun to scratch the surface in the fields of chemistry and physics involved and has yielded little help except in the production and control of raw materials. And this will continue to be the case until many basic questions are answered.

In the meantime, further improvements in lithographic inks should be possible through empirical developments along the following lines:

1. Inks that will take up and emulsify less water during printing.
2. Inks that have less tendency to emulsify in the plate moisture and cause tinting and streaks.
3. Ink driers that are less affected by moisture in the paper or by the weakly acid fountain solutions.
4. Inks that require less oxygen for drying and will therefore dry more completely on piled sheets.
5. Inks that are more scuff resistant after drying.

These are not new suggestions to ink chemists, but effective research depends to a large extent on the development of helpful laboratory techniques to take the place of practical printing tests that involve so many variables in themselves that they are highly undependable.

SUMMARY

The foregoing is a brief review of some of the problems and pitfalls in offset printing on coated papers that relate to the printing process rather than to the paper. Coated papers require a higher precision and more perfect functioning of the press than uncoated papers. Improved printing plates that require a minimum of dampening are a great help in avoiding printing defects, in preventing curl and dimensional changes in paper, and in promoting the proper drying of inks.

Coated Paper in Offset Printing

The panel discussion on factors involved in offset printing of coated papers convened on Monday, May 25, 1953. Chairman A. C. Zettlemoyer, National Printing Ink Research Institute, Bethlehem, Pa., presided.

CHAIRMAN ZETTLEMOYER: There have been a number of questions concerning pH, so we are going to open up this panel discussion by addressing one of the questions raised to Mr. Frost: "What is the proper pH for papers for lithographic printing? Is it different for coated and noncoated papers?"

F. H. FROST (S. D. Warren Co., Cumberland Mills, Me.): I think that is a question that has a great deal of controversy involved in it. Let's take a look first at uncoated paper which if sized, will have low pH. Generally I think you will find that there has been very little trouble with ink drying on paper of that type. Even though pH may be down $4^1/_2$ or 5. Next let's take a look at a coated one side paper of a varnished quality with a high ratio of casein to pigment which is relatively impervious to the vehicle of the ink. When you print such a sheet a small amount of absorption takes place and the ink formulation that you started with in the press is fairly comparable to the ink formulation that you end with in the print. I think that you will find that there has been, relatively speaking, not too much trouble with ink drying on a sheet of paper like that, even through the pH may be down around 6. However, I do believe that you get into trouble when you talk about absorptive sheets. In other words, it isn't a question of pH alone, it is a question of pH and absorption. I don't think absorption itself is any explanation, but I have heard it explained this way. When you start off with a particular ink formula, you put a film of that particular formula on an absorptive sheet, a fairly large percentage of your vehicle may be drained by the fine capillaries of the coating down into the coating, maybe even into the body stock. When you do that, if you are using driers that are soluble in your vehicle, you are also taking away driers from the surface. When you do that you are raising the proportion of the pigment to driers left. The higher the proportion of pigment to the proportion of drier, the more absorptivity of the drier you have on the pigment; the more absorptivity on the pigment, the less effective the drier is in aiding in the oxidation of the varnish. Well, that is the explanation that I have heard and it seems to me to be the best one.

You get into trouble with a pH below 7 on that type of paper, or you are apt to. I think that is primarily the area of trouble from pH. The advantage is more or less on papers that are nonabsorptive whether they are coated or not coated.

CHAIRMAN: The next question I will address to Mr. Riddell: "You say large solids require soft blankets for best results in offset printing of coated sheets, and vice versa. Can you explain your reasoning on this?"

DAVID W. S. RIDDELL (The Montreal Lithographing Co., Ltd., Montreal, Que.): When I said that soft blankets tend to give effectively better printing of large solids than would a hard blanket, I first of all qualified that statement by saying that the difference between a hard and a soft blanket is ex-

tremely slight, it is a very difficult thing to measure, as a matter of fact. When I said that soft blankets apparently give improved printing of large solids, I was speaking from experience. We have noticed that in our own plant. We have conducted fairly extensive testing on so-called hard and soft blankets. We have noticed an improved printing of solids due to using a softer blanket. Whether that is the only factor involved, I really don't know. I also wasn't referring particularly to coated paper when I spoke, my talk was based particularly on nonpaper factors. A soft blanket is an asset in printing solids on uncoated paper as well as on coated papers. I hope that answers the question.

CHAIRMAN: Mr. King: "For a normal sheet of coated paper, how often must a press be stopped for a wash-up?"

CHARLES F. KING (U. S. Printing & Lithograph Co., Cincinnati, Ohio): That depends an awful lot on the paper. It is nothing unusual to wash a press every 500 sheets with some types, especially of board, coated boards. And Mr. Reed referred to dust, slitter dust, and so forth, and on board it is worse than it is on paper. Of course, when we get that we begin calling in the papermaker to prove to him that it is his fault (attempt to prove it) because with the equipment we have, some of it with hourly charges running as high as 40 and 50 dollars you are supposed to put so many sheets out every hour. People in my position have to account for every hour. If there are that many delays (wash-up every 500 sheets) we have lost 28,000 sheets per day, I am on the carpet.

But generally speaking, we can run, or attempt to run 10,000 to 12,000 sheets, which is a skid load, and not have any wash-ups in between. That is what we attempt to run. We don't always do it.

CHAIRMAN. For Mr. Dankert: "How can offset inks be made odorless and tasteless?"

F. S. DANKERT (Sun Chemical Co., East Rutherford, N. J.): Well, that is not possible to do entirely for the simple reason that the materials used in making offset inks are a combination of resinous materials, solvents, certain types of pigments, driers—all which have an odor in themselves. However, there are certain types of linseed varnishes that are treated to keep the odor down to a minimum. Recently there are certain types of solvents that are getting to that point, and certain treated oils. There have been improvements along that line to make them odorless as much as possible. Actually, I have never seen yet a lithographic ink that could be completely odorless for the simple reason that the factor of drying alone creates that condition of odor. That in itself creates some odor in the ink. The only way that I know that completely odorless ink can be made is in the type that is not possible to run by lithography. This is the steam-set type which is composed of the materials that once dried have no odor at all. This has not been run on a lithographic press because of the simple reason that they dry by moisture.

CHAIRMAN: The fellow should have added nontoxicity to that list. There is quite a problem on that in the industry for packaging and so forth. I like the response that Mr. Erikson makes to an inquiry about nontoxicity of inks. He points out that even if we make ink entirely out of water it wouldn't be nontoxic because even water is toxic if you drink enough of it.

CHAIRMAN:

For Mr. Frost: "Do you consider tunnel drying of a coated sheet (15 lb. coated one side) detrimental to wax pick (or bonding) and folding (or scoring) over slower festoon drying? If so, what can be done to correct the tunnel drying?" He also gives his formula for coating, but we won't reveal that to the audience.

MR. FROST: That is another good question. If, in your tunnel drier, you have metal sticks that are holding your paper, say, spaced about 11 in. apart, and the paper is directly in contact with those metal sticks, you can get areas of weakness at that point.

Now if you print it on a printing press you will find the paper is very weak where it was in contact with metal. The way to overcome that is to use an asbestos rope, wind that around your sticks, and then you won't experience that trouble. I think, in general, if your sticks are properly wound that you don't get too much difference in wax pick, whether you tunnel dry or festoon dry. I think you are apt to find that your body stock strength isn't improved as much in tunnel drying as it is in festoon drying. To overcome that I would make the coating wet the body stock better and be careful not to size the body stock too hard. I think that might help.

CHAIRMAN: We have a signed comment here that the panel thinks is too good to pass up; we are like the editor of the local paper who removes the signature when he prints the letter to the editor and then adds that it was anonymous.

No. 1: "Suggest that all offset printers and offset inkmakers present at this meeting offer a resolution of apology to all old-time coated papermakers present for all the trouble they made us in the early thirties, because they blamed all their troubles on the coated paper, while most of their troubles were the results of their own not knowing enough about offset inks, fountain solutions, blankets, metal plates, etc."

No. 2: "Suggest to the Chairman of Coating Conference and to National TAPPI that they publish all papers read today *in toto* in one of the next *Tappi* issues."

No. 3: "Where are last year's papers published?" (*Ed. Note: Tappi* 36, No. 2: 148A–178A (Feb., 1953).) "I mean all except those on starch which were combined nicely into a reprint. Thanks to the starch manufacturers for this service."

There have been a number of questions concerning bonding strength, picking tendency, and the like, and I will address this question to the panel generally, and perhaps we can elicit some comments on various techniques now being proposed today and the merits and demerits of the Dennison wax test which all of us know about historically, at least: "What value has a Vandercook proof press for predicting comparative picking tendency of base stock, particularly in paper mill laboratory? Are there other quick comparative tests? Assuming that wax pick may be misleading."

Now, this brings up a number of questions and we will ask the panel to take this up as they wish. Mr. Reed?

ROBERT F. REED (Lithographic Technical Foundation, Chicago, Ill.): Well, certainly the Vandercook proof press has been used, and I think successfully, for comparing the pick strength of the papers. If you use a solid cut and uniform inking and run two papers through at the same time, varying the speed or the tack of the ink, you can make one paper pick when the other doesn't. If you always run one specimen of sheet that you know has worked satisfactorily you can get a comparison with that sheet—either the other sheet isn't as good, is as good, or is better.

Now that, from the work that we have done on pick testing, is true at least as far as letterpress printing is concerned. When it comes to evaluating papers for picking in offset printing, I think we have a little different situation. We have made tests, using the wax test always for comparison, of two of the instruments that have been proposed for increasing the pick strength of paper. Both of them operate on the letterpress principle, in other words, they print directly from a metal surface to the paper, not metal to blanket to paper. By using a technique that we developed in the laboratory of applying the series of I.P.I. tack-tested inks on the offset press, applying a half a thousandth film of each ink to a different area of the blanket, and running a sheet through at 4000 sheets per hour, we could always make the paper pick with one of these tack-tested inks. We felt that that represented an actual press test, outside of the fact that we didn't use any moisture. It was probably the best criterion of what good paper would stand on the press. We made comparisons with

results of the wax test and found the latter weren't very good. These other instruments, I won't name them, gave different correlations with the offset press test, but not too good. They didn't correlate very well with the wax test. I am leading up to the fact, that we did develop a pick tester ourselves which is going to be on the market within a matter of a few days now, which is based on the offset principle, and which has been built to correlate with the results of the press tests in our own laboratory. And since we have done that it will properly grade papers with regard to picking on the offset press.

There is considerable difference in the offset impression as compared with the letterpress impression, not only in thickness of ink film and the tackiness of the ink, but in the mechanical nature of the impression. Just as an example, one of our friends sent in a paper not very long ago that showed a wax test on one side of 3, and on the other side of 11. Both sides picked on the offset press. When Gordon ran it on our own pick tester, what was it we found?

MR. WHEELER: Three and four.

MR. REED: It picked with ink No. 3 on one side and with No. 4 on the other. So the two sides were not so different. Why the wax test gave such an enormous difference, we don't know, but that is characteristic of certain papers on which the wax test simply does not work.

QUESTION: I wondered if this pick tester you developed is applicable to a letterpress operation on coated board?

MR. REED: To letterpress?

QUESTION: Is it applicable to evaluating coated board for letterpress operation?

MR. REED: I think it can be used for that purpose simply by omitting the blanket from the printing element. We do place a piece of offset blanket on the printing element, and I believe that can be done by simply omitting the blanket.

GORDON WHEELER (Lithographic Technical Foundation, Chicago, Ill.): We haven't tried it yet.

MR. REED: I say, I believe. We actually haven't done it. We have been working on offset, so that is something that has to be determined yet.

MR. DANKERT: I just want to make a point on that. I think the pick tester that the L.T.F. designed is very close to giving a definite reading for paper. In our laboratory what we usually do is to combine picking with stability of an ink. We use the Vandercook press and we have a split fountain. We use a given amount of ink on the fountain. Both sides hold two different inks, and we run the paper through and leave it there and run it every 5 min. or so, just to see the stability. This is not a direct relationship to the paper itself, because we in turn are trying to make an ink that will be stable and will print. But it does give you some values as to a paper, which one will pick or which one will not. In this way we try to evaluate by running a given amount of ink on a roller, continuously run it over a period of half an hour or an hour, and that tells us somewhat the strength of the paper. It is a medium of the stability as well as the picking of ink for running over a long period of time.

MR. FROST: I would like to make a couple of comments on the wax test because I think the test can be extremely useful for certain things if used and interpreted correctly. I recall the experience about 15 years ago where we took some clay and put it in a very heavy duty mixer and practically polished it by rubbing one particle against another, in a practically dry state. I found that by doing that we could raise the wax test, all other factors being equal, from no pick on 4 to no pick on no. 10. I certainly thought I had a way to reduce the casein requirement and we were quite elated about it until we took it up to the print shop and checked and found that under those conditions even on no pick at 10 and no pick at 4, we had exactly the same resistance to picking.

Looking into it further, we found that calcium carbonate of certain types might give a very low wax test, yet actually have the same resistance as clay with a much higher wax test on the press. But if using a particular formula with a particular pigment combination, and you are not involved with rubber latex, such as 512K, then you get a perfectly reliable indication from the wax test, but you can't compare different formulations. I am sorry Mr. Reynolds isn't here because he is working on a method that I think has a lot of possibility for measuring pick test and also measuring receptivity of paper. He has developed what he calls a wedge which lays, which you put in the letterpress just the way you would put in a halftone, and it is graduated so that you put an increasingly thick film on the sheet of paper when you print. I think if you put that wedge in a Vandercook press and lay down this gradually increasing thickness of ink film, it will give you a very nice test of ink sensitivity and control against known standards. I think though that you can get an excellent reliable test of picking. Anybody that would be interested in that, I am sure if they write to Mr. Reynolds he will be delighted to give you more information about it.

CHAIRMAN: It might be a good time to point out that there are many pick testers now on the market. I am reminded of the I.G.T. instrument from Holland which some of us have seen, the Hercules print tester now made by Brookfield Engineering. We have heard about the L.T.F. tester and the wedge test of S. D. Warren. There are also several others, including the Waldron pick tester and the large and rather immobile unit built at the Paper Institute. This variety of instruments has suggested that some work be done to analyze the features one against the other, and the Printing Institute in cooperation with TAPPI has inaugurated a program for testing each of these machines except the Paper Institute machine which it isn't possible to get down to Lehigh. Any of you who have papers or board stock you want to get in those series, as long as we are not deluged, should send samples to NPIRI.

The next question is addressed to Mr. King. "Does the wettability of the sheet in regard to water wettability of the surface or absorption of water by the surface affect the blanket or plate action? Is it of importance? The possible example might be in the case of wax-coated sheets."

MR. KING: I am glad that wax-coated sheets was included because I was a little in doubt about how to answer it. Definitely, if you have a wax-coated sheet and you transfer wax to the surface of the blanket it is going to work back onto the plate and cause the areas of the plate to take ink that are not supposed to. That has been the case in even some cases when they tried to use wax sprays for offset prevention on offset work. The sheet went through the press a second time and picked up some of the wax. I know of attempts that were made about 15 years ago to use wax sprays.

So wax or any material that could transfer to the blanket and then back to the plate, if it is a material which is greasy, will definitely affect the printing quality of the plate.

CHAIRMAN. Another one for Mr. Frost: "Mr. Frost feels that the importance of insolubility for offset coatings has been exaggerated."

MR. FROST: Suppose that we have a coated surface that is relatively soluble in water. When is it going to get wet? It is going to get wet during the impression between the paper and the blanket. How much time is going to be involved? Well, the time that is involved for wetting is going to be, say between a hundredth of a second and a tenth of a second. Now, if that sheet doesn't wet with water in a tenth of a second, why are you going to be worried about whether it is soluble or not? Because don't you have to have wetting before you can have solubility? In other words, if the sheet has a duck's back effect, as that impression rides across the sheet, I don't see how materials are dissolved from the sheet and go back up into your ink or water fountain. Yet on the other hand, suppose that we have a sheet in which we tied the casein up with formaldehyde, reacting with the amino

groups, which is an irreversible reaction and can make the casein quite insoluble. That is what we mean when we talk about a waterproof sheet. That does not mean, however, that there are not other materials in that sheet, such as excess alkalinity, that will still be soluble in water.

Now if that sheet wets very readily with water, those materials can dissolve, can go back on the blanket, go from the blanket to the plate back up into the fountain solution and raise the pH of the fountain solution. So it seems to me you can get in trouble with a sheet that is highly insoluble or from a sheet that hasn't been solubilized. But you must take into consideration the question of the resistance of the sheet, of the surface of the sheet to wetting and if you don't do that I don't think you get the whole story.

QUESTION: Let's assume for the first time a small lithographer gets hold of one of these reasonably machine coated sheets and he has to flood the job because of a poor plate he hasn't made. The job tints or scums, he takes your sheet off and puts on a casein or properly waterproofed sheet and it runs well. Do you feel he has a reasonably justified complaint?

MR. FROST: Sure. Don't you?

FLOOR: Yes.

MR. RIDDELL: I would like to add something to what Mr. Frost had to say there. He mentioned a time of the sheet getting wet as being between one-tenth and one-hundredth of a second, I believe. That is true for single colored printing. However, in multicolored printing, if you can get a film of water on the sheet, although it is not actually wet by the water, it has a substantially longer period than that to pass through the remaining three or four units, depending on whether it is a four or five color press.

To me the feature that we seem to desire in a coated paper for offset lithography is more a sheet of paper which will be wet by and absorb water, but the coating will not dissolve in water. It is possible to have wettability without solubilization.

MR. FROST: We are going to have an argument going here. About 10 years ago I got a so-called bright idea. It occurred to me that it would be swell to make a sheet of paper that wouldn't take up any water by offset lithography, so you could cut the water down on press to a very minimum. We made such a sheet and took it out and tested it. The sheet you could hold under a tap and the water would roll right off, wouldn't wet at all. We found it impossible to adjust the water system of the press so that sheet would run. We could spit on the plate about every 500 impressions and that was enough water to keep the plate clean, but you could not regulate the fountain so the plate would run clean.

Well, then we tried the opposite. We made a sheet of paper that was highly absorptive to water. We found that when you did that, that plate literally stripped all the water off the blanket. It was no good. I think it is true that on the blanket we have a visible image of ink, and we have a relatively invisible opposite image of water. That water was stripped clean from the blanket. When the blanket came around and contacted the plate it took much more water off the plate. That required more water from the fountain. We found that that type of paper required 5 oz. on the fountain to run. When we did that we emulsified the ink, ruined the plate, got about a thousand impressions.

I think you have to have a certain amount of water taken away by the paper. But I think one of the most important things in a proper lithograph sheet is a control, and a definite control of the amount of water the paper will take away. You can go too far and you definitely can take away too much. But when you control it correctly, when you have the right water repellency, and when you have the right ink absorptivity and wettability, then you have a real sheet of offset paper.

CHAIRMAN: We have the next question for Mr. Dankert: "Is porosity of coated paper a factor in ink chalking? If so, at what porosity do you begin to have trouble?"

MR. DANKERT: Well, I don't know definitely of what porosity the surface would have trouble. The fact is that I don't think the porosity is entirely the fault. Certainly coated papers that have a certain amount of absorption are more receptive to ink. To maintain those conditions, as I know them, you have to treat your ink to resist the condition of chalking after printing. I mentioned earlier in my talk that the faster setting inks, the solvent-type inks, do prevent that condition. The reason for it is that you get a certain absorption, then on the surface of your paper you get a binder due to the resin content in the formulation, so that the ink, when it hits that paper, may be absorbed very quickly, but it will also dry. Now, if you had to go back to the old type of a linseed ink, the problem is intensified. Then porosity may be a factor because you have to condition with the ink setting into the paper, losing the binder, resulting in a condition of chalking. So to my way of thinking it is a matter of technique and particularly making the ink fit the particular type of paper.

CHAIRMAN: To Mr. King: "Is high-gloss ink printing being made possible by lithography on coated papers without the overprint varnish operation? If so, is offset ink a controlling factor?"

MR. KING: The most important thing in any gloss ink printing, regardless of whether it is offset or letterpress, is the coating itself. It doesn't matter how well the ink maker may formulate an ink, he is completely licked if the surface paper is not made for gloss ink. I wish I could get the idea over to some people that it does not necessarily mean that it needs to be a good varnishing grade sheet because that is not necessarily so. Merely because a sheet is good for varnishing doesn't mean it is good for gloss ink for offset or letterpress. It is mainly due to the wettability factor.

We produce offset and letterpress jobs interchangeably in gloss ink. Now it may scare some of you, but we do. We are very particular about what paper we will use or can use, and offsetting is a factor. But the same type of dry spray we use on our letterpress presses will also prevent the offsetting on our offset presses. It is less of a problem on offset because you have a thinner ink film.

CHAIRMAN: The next one is for Mr. Frost: "What is meant by: reverse embossing? waffling? tail end hook? Are they different terms for the same property?"

MR. FROST: The tail end hook has nothing to do with a fish story. When a sheet of paper is printed on an offset press, the further you get away from the grippers the more stretch is possible in the sheet. You can put in a permanent stretch particularly in the tail of the sheet so when it comes off you get this effect (illustrating with a sheet of paper). That is what we mean by tail end hook. You don't exceed the elastic limit of the sheet to the extent that you actually break the sheet, but you do bend it to the point where you get a permanent hook. And it is related to the stiffness, to the folding strength of the sheet of paper.

Now reverse embossing is more or less the same, due to the same type of causes, but occurs somewhat differently. Suppose in the center of the sheet you have a solid. As you pull that sheet off the blanket, if the pull pulls the sheet up, where the solid was printed so that when you look on the back you see it has been indented, we call that waffling or reverse embossing. Just the opposite of what you get in letterpress printing when a heavy impression here will emboss here. A heavy pull here can pull the sheet in that way. It is actually a stretch of the sheet that takes place. So waffling and reverse embossing are the same. Tail end hook is different.

Oh, here is a question: "Comment on stiffness." I am going to guess what that means. I think you are all aware of the coated sheet of paper that can be made today using the synthetic latex that is extremely flexible. I think you

can go far enough so that you can get yourself in trouble, particularly in feeding on an offset press. However, once you get by the press, particularly now if you are talking about coated one side labels, a sheet that will conform to the can or to a bottle, a limp sheet, is very often an excellent sheet for labeling. So I think you've got to strike a compromise in the stiffness that you can have in a sheet of paper so you don't get so stiff that you interfere with the labeling operation so that when you put the labeling around the can the stiffness will tend to snap it off, and you don't get it so limp that you have trouble feeding it into the press. Again, like everything else in our business, you have to compromise.

CHAIRMAN: The next one is for Mr. Riddell: "Have you seen any connection between fineness of the grain in the plate and nature of the coated paper for good print quality?"

MR. RIDDELL: I don't believe the two are interrelated in the least. Fineness of grain has been found a factor on print quality in itself. To get optimum print quality with fine line detail work, actually a smooth plate will give you that optimum detail. The paper has very little to do with that with respect to the grain of the plate.

CHAIRMAN: There are a group of them here for Mr. Reed. I will read them in entirety before I ask him to start commenting.

The first is: "What is the ink film thickness normally used on offset presses? That is, between what limits?"

The second: "Is the quantity of ink carried different in printing on metal or foil as compared to printing on coated paper? If so, why?"

The third: "Has experimental work been done to measure the per cent of ink transferred from blanket to printed surfaces? Is 'ink receptivity' a function of wettability or smoothness?"

MR. REED: We have tried very carefully to measure the ink film thickness under actual printing conditions on the offset press, and it can vary within considerable limits. On the average I would say that you carry roughly a half a thousandth, or $12^1/_2$ mu ink film thickness on the form rollers of the press. Now the four form rollers have an addition effect so that the ink film thickness on the plate is almost, but not that much. Calculating theoretically, and assuming that the ink divided equally between each roller and the form, which we think is probably true or very close to true, if you have $12^1/_2$ mu on the form rollers, you will have about 10 mu of ink on the plate.

The blanket is somewhat absorbent and the printing area of the blanket will absorb the ink vehicle to a certain point before you get maximum printing quality or transfer of ink to the paper. After that point is reached you can assume that you have half of the ink that is on the plate transferred to the blanket, which is about 5 mu. Then the transfer of ink from the blanket to the paper depends entirely on the ink receptivity of the paper. Now I am using that term "ink receptivity" with my tongue in my cheek because I don't believe anybody has really defined ink receptivity. It is just a term that we use to describe something that we don't quite understand.

Anyhow, considerable work has been done on that transfer to the paper. The Swedish Graphic Arts Research Laboratory gave a paper, I believe it was the TAPPI meeting in New York in February, at which they gave some results. The less absorbent the sheet, the more nearly fifty-fifty transfer it got. So, if you have 5 mu of ink on the blanket, you would transfer a minimum of $2^1/_2$ mu. But it was always slightly more than half. With very hard papers, nonabsorptive papers, it was very close to half, but with very absorbent papers it could be, well I forget the exact figures, but close to 65% of the ink being transferred from the blanket to the paper.

Now as far as the limits are concerned, that is how much the amount of ink transferred can vary, frankly I don't have any good figures, but I believe it can vary at least 100%. In other words, instead of $2^1/_2$ mu of ink transferred to the sheet, you could apply as much as 5, on certain types of forms. Or you could go down to possibly half, or $1^1/_4$ mu of ink. I think that that is being done right along with the pressman having two ways of producing a tint. He can either dilute his ink to give him a proper color, or run less ink. He can run the ink very spare, as they say, and apply as little as $1^1/_4$ mu.

Second question: "Is the quantity of ink carried different in printing on metal or foil as compared to coated paper?" I haven't any figures on printing on metal or foil. I think the same principle holds except that the metal or foil does not have porosity and that you transfer very close to half the ink that is on the blanket to the metal or to the foil. I think you have approximately the same leeway for extra ink or less ink, depending on the result that you want.

The third: "Has experimental work been done to measure the per cent of ink transferred from blanket to printed surface?" Yes, I think I have answered that question. "Is 'ink receptivity' a function of wettability or smoothness?" Well, there is a question that is open to a lot of controversy, and I am not going to stick my neck out too far on it. I think that in order to get ink transfer at all you have to have wettability. If you didn't have wettability, you wouldn't get transfer. How much ink is transferred then, if the sheet is wettable, will depend on the amount of ink that you carry and the character or body of the ink. If it is a completely workable ink, that is, if it isn't excessively short, then you will have normal amounts transferred to the sheet. But if the ink is too short or becomes too short or buttery due to excessive emulsification of fountain water in it, then part of the ink may cake on the blanket and you will not have the proper amount transferred to the paper. You will then have weak print. And that condition continues to build up a cake on the blanket until you have to stop and clean up.

Smoothness, I think, doesn't enter into the question except as to the amount of ink necessary for coverage. The smoother the paper, the less ink is needed to cover it and give the desired ink intensity in the print. That is why the very smooth offset papers and very high gloss papers with smooth, mirror-like surface can be printed with so little ink with beautiful, sharp halftones, whereas if you try to get something like that on eggshell or an uncoated paper you lack the intensity even though you use a good deal more ink. Smoothness, therefore, is the thing that controls the amount of ink necessary to give the desired result on the paper. And as to how to measure smoothness, that is something else.

CHAIRMAN: One of the themes—there seem to be several themes running through these questions—one that seems to be very important and touches on various aspects of printing of coated paper, it has to do with ink transfer, ink transfer at various points in the process. I might say that we are cognizant of this important property of inks, in our work at the Printing Institute, and some recent results which are not completed show some things that we would never have guessed. I am speaking now about the transfer from metal plate to paper, that is various coated papers, and I am speaking about it on a Vandercook no. 4, but under a variety of carefully controlled and measured printed pressures.

The interesting thing that we have found is that the per cent transferred very little with the nature of the coated paper over a wide range of pressures, and over the entire range of ink film thicknesses which might be considered to be practical. This rather surprises us since it is quite opposite to some findings in Sweden.

The next question is addressed to Mr. Frost: "You stated that wet-strength resins could be used satisfactorily to reduce expansion and stretch, but that the cost is too high. At what resin content and resin cost would satisfactory paper costs be obtained?"

Mr. Frost: I bet a buck to a dime that question comes from a friend of mine who manufactures resin. If you use 2% wet-strength resin, cut your beating in half, you will come up with a stronger sheet than if you had used no resin and full beating. You will get a major reduction in expansion, you will have a sheet that will coat very much better, you will have a major reduction in curl. The cost isn't involved in how much the resin costs. The cost is involved in segregating and keeping separate through a complicated operation, your broke. Because if you get wet-strength broke back with your normal broke, you can easily ruin 50 tons of paper. When partially broken up, wet strength paper produces fibrous groups and clumps that will ruin your subsequent production; that is where your hazard is and that is where your cost is.

I would kind of like to throw that question back a little bit. When you use the resin that way you are not taking advantage and you are not using wet strength at all. What you are doing is, you are taking advantage of the dry strength that that resin produces, because I am not talking about the increase in strength you get when the paper is wet, I am talking about the increase in strength you get when the paper is dry. Therefore, the fact that the resin produces wet strength is the thing that is immaterial and harmful. What we want is a resin that is a little cheaper, that does not have wet strength, but does produce the dry strength. Then we can afford to use it and make a much better paper.

Question: How about the factor of expansivity you mentioned in your paper?

Mr. Frost: We get a very large reduction in expansivity because you cut your beating in half. You can cut it about 50%.

Question: You mean cutting down the beating time?

Mr. Frost: Sure.

Question: But suppose a customer doesn't want blotting paper? He wants bond paper.

Mr. Frost: The point is, if you use this wet-strength resin it has the property of producing a great increase in dry strength, and if you will compare the stiffness and the fold of a paper, beaten one half as much, you will find it is stronger than the same finish beating twice as much. So you don't get blotting paper. You get a good paper.

Question: I don't quite a hundred per cent agree with that statement because in certain grades of paper you want a certain surface and you need a certain beating, so if that were cheaper than that strength resin, it would be better.

Chairman: I think what the gentleman is pointing out is he thinks in certain types of papers you have to beat it in order to get certain properties and you want to add resin for other properties.

Floor: Yes.

Mr. Frost: What are those properties?

Floor: Reduction of wet expansivity.

Mr. Frost: Our figures show that you get a reduction of wet expansivity as well as reduction of the expansivity due to variations in moisture, in humidity, if you cut your beating and use resin.

Chairman: Another one for Mr. Frost: "Can some starch adhesive be used successfully in place of casein in a coated offset paper?"

Mr. Frost: We were discussing a moment ago the necessity of waterproofing a coating for offset printing. There is a little bit more to the story than that. We limited that discussion to the effects in the offset press. We are discussing a label paper, however, and the sheet is not waterproof. You may be printing 20 or 15 labels on the same sheet of paper. One of those labels may be applied to whatever it is going to be applied to with a wet rag, and if it isn't thoroughly set up you will get in trouble with the labeling operation even though you may be all right in your offset process. So generally if you would be safe for labeling as well as printing, you have to have waterproof surface. There is no difficulty in making a starch coated sheet which is waterproof. There isn't any difficulty in running such a sheet in the press nor in labeling it. But in order to make it waterproof, if you've got to waterproof it on the acid side, you get in trouble with ink drying. So what we need is a safe, sure method for waterproofing starch coated paper on the alkaline side. Once we have that, I think you can make a sheet of paper as good with starch as with casein or any other adhesive.

Chairman: One for Mr. King: "Is the key to good wettability essentially one brought about by the type of vehicle employed in the ink?"

Mr. King: The ink vehicle composition has much to do with wettability of the surface of the paper. The fact that it is the improved wettability to some extent and absorptiveness of these new resin materials Mr. Dankert was talking about that has made a lot of the advances in coated paper printing by lithography possible. And you can add materials to an ink which will wet paper more easily and make it print much better. It is being done.

Chairman: Mr. Dankert: "How do the three types of inks you mentioned compare as to cost, both per pound and finished job?"

Mr. Dankert: Well, actually the relative cost of the ink is a very minor portion when you get the job, so in all cases the best ink is usually the cheapest in the long run. The cost in any given ink is dependent mainly upon the type of pigments used and formulation. Actually, there isn't a great deal of difference in any of them. It is basically how it is compounded and what materials are put in it. Your basic cost as far as vehicles are concerned is probably a little higher when the faster set is concerned. However, that is only a minor portion of it, and basically the big cost is in the pigments themselves. They will range all the way from a cheaper ink up to a higher one, depending on what is used. So, relatively it is hard to see any difference in it. It is basically on the principal formulation of that ink at a given time. And over all, as I said, the best ink is the cheapest one in the long run.

Chairman: Mr. Riddell: "Do you believe that printers in general understand the meaning of pH and the control of it? Do you believe they pay sufficient attention to it? And do they generally test coated papers for the effect of water or fountain solutions on them?"

Mr. Riddell: By "printers" I assume you refer to lithographers. Generally I don't believe lithographers do understand the meaning of pH or the control of it. To the best of my knowledge there are only about four or five pH meters in use in lithographic plants in Canada, and there are more lithographers than that.

Do they pay sufficient attention to it? I think the first part of the question answers that, although recently I think a number of lithographers have gone completely overboard and overemphasized the importance of pH. pH isn't the full story in controlling any one of the phases of our operation.

Is testing of water resistance of coated papers by water alone adequate? That is a question I think I would like to turn over to Mr. Frost or Mr. Reed.

Would a fountain solution be more indicative? Oh, I see, the second part of the question clarifies the first. Yes, the fountain solution which you are going to use to run that specific lot of paper would naturally be more indicative; as to whether or not there would be any difference between it and water alone, I really couldn't say. I have never conducted any tests along those lines myself. Possibly some of these other gentlemen have.

Mr. Reed: I want to make one comment on the first part of this, the first question here. We have been told by manufacturers of electrometric pH meters within the past year that the lithographers have been the largest single group or single industry purchasing pH meters. It took many years. We originally began to talk pH about 1934, actual use of pH

in the lithographic shop, and it took many years for the idea to take hold, but just since the war I think there has been a very great increase in the number of shops. I understand there are probably 7000 or 7500 lithographing shops of all sizes in the United States. Even now it would be hard to guess how many have them, but if even a thousand shops have them, that is a large number, and certainly we know that most all of the larger shops have pH meters. And they turn out by far the most work.

"Is testing of water resistance of coated papers by water alone adequate? Would fountain solutions be more indicative?" Frankly, I don't know. We have never done that, and at the present time all we use is plain water. Frankly, I think from the low concentration of materials in the fountain water that I showed you this afternoon, that there should be very little, if any, difference between that and water. And the reproducibility, the fact that you would have to use the same solution all the time, would indicate that probably if you used water alone it would give you sufficient indication of the moisture resistance of the paper.

CHAIRMAN: The next question is addressed to Mr. Frost: "Is the ratio of coating weight to rawstock important relative to operability of coated offset paper?"

MR. FROST: Personally, I believe it is. In true coated papers you put a film of adhesive and pigment over the surface that buries your fibers so that you are printing on a film of adhesive and filler, and not a combination of one on part of the other. Unless you get that continuous layer, I don't think you will succeed in making a coated layer that will operate well or print well. Generally, on most raw stock your dividing line is around 8 lb. per ream, 25 × 38–500 and if you go below that you are liable to end up with part fibers and part pigment interposed and not too good a coated surface. Therefore, to be safe generally the coating is increased to 12 or 15 lb. per side in order to be sure to get a continuous film.

CHAIRMAN: Mr. Reed: "Please discuss again your statement, 'Less moisture, greater piling.'"

MR. REED: I don't know how to discuss that except to tell you just what we did. On our offset press we waxed the dampers at one end and graduated the amount of wax along the dampers leaving the other end of the damper normal so that the amount of moisture transferred to the plate by the dampers varied from one end to the other. And then by running sheets through the press, using a plate with a synthetic image on it, we would notice the amount of piling on different areas receiving different amounts of moisture. Most of the piling always occurred in that area that had a marginal amount of moisture, just barely enough moisture to keep it clean. And there usually was also piling in the adjacent area where the plate was just a little too dry to stay clean, and there the ink accumulated pigment from the paper surface and piled also.

If you are running black ink, you will see this white build-up of coating in the relatively dry area of the moistened plate, and on the area adjacent to it we would tend to see a build-up of black deposit which was not all ink. And that is all that I can tell you about it. It is purely experimental. We find that the less moisture we run on the plate, the more the paper shows a tendency to pile. And you can have a paper that will pile under those conditions, and yet on the wet end you may get no piling at all.

CHAIRMAN: This is addressed to the panel. I am going to ask Mr. Dankert to comment on it first. "What has been the experience of the panel in printing coated papers or boards which have a continuous film of some resinous coating such as polyethylene, polyvinyl acetate, and other similar materials? Do these coatings require special inks or special methods of application?"

MR. DANKERT: On these special surfaces you definitely need a special type ink, mainly for the purpose of adhesion in drying. Polyethylene, I would say, would be very difficult for the simple reason that the surface is very repellent to most types of solvents. However on polyvinyl acetate and the other types, such as cellulose acetate, those films can be printed, and they will print very well. However, the problem there is not so much in the printing as in the delivery in stacking up the sheets. It is not possible to get immediate drying, so the chances are that you may get offset. However, if the film is run very spare and the back of the sheet is rough and a spray is used, in many cases you can get by by running on some of these surfaces. But usually it does require a lot of care and a lot of special handling, not to stack the sheets too high, and a special drying ink so the adhesion is perfect to that surface.

In all cases each plastic surface may have to have a special ink, because these plastics are not the same. In many cases you have to make variations in your ink to fit those different types of surfaces.

CHAIRMAN: Here is one I will ask the panel to answer, "What is the effect in terms of holdup and discoloration on the varnish quality of a coated litho having an ink wettable surface versus a hard sized surface?" He mentions spirit and press varnishing. Mr. Dankert?

MR. DANKERT: I don't quite get the effect of this question. Actually, I can't see the ink having any effect of discoloration on the paper. I do know, I was talking about a varnish quality of the coated litho in having an ink wettable surface versus a hard sized surface. Well, it is again a question of surfaces of the paper. Some surfaces are more receptive, and again it is a matter of making that ink fit that surface, making it wettable, against certain papers that have more receptivity to that ink. I don't think it matters much about the varnishing of the sheet itself. I don't believe the varnished paper has any effect upon it. The ink will print in most cases unless it is an extremely offtype paper.

MR. KING: If I understand this question correctly, I think the questioner is referring to the fact that some coated papers do discolor when you put varnish on them, and some of them with the highest brightness discolor the worst, and you end up with a varnished sheet that is sometimes quite transparent and often very muddy appearing, perhaps due to the carbonate in the coating becoming transparent when we put a spirit varnish or even overprint on it. It happens both with coated papers and boards. You get a beautifully white sheet and it has a good varnish holdup in some cases, but you have the most horrible looking mess the minute you put varnish on it, and the original brightness has no bearing at all on what you end up with. They also do have very funny discoloring when you put them in the fadeometer.

So far as the job that is going to be varnished, the original brightness and color both are no indication of what you are going to end up with. It is really a problem.

CHAIRMAN: Mr. Frost: "What instrument or method do you feel measures the internal bonding of raw stock most adequately?"

MR. FROST: I am probably more prejudiced on this one than on the others, but Mr. Sutermeister—for whom I have a warm spot in my heart—developed a method of measuring internal bonding which seemed to me to be the best I have seen. He took a sheet of paper and he put it between two brass disks, having put on each disk a sheet of rubber. He pressed them together so he had an adhesive bond between the brass, the rubber, and the sheet of paper. Then he measured the force required to pull them apart. That test always split the body stock, the coating never gave way, and he got a numerical result. I think the correlation of that result with what you find in offset printing is almost perfect. The reason that the test hasn't come into widespread use is because only certain types of rubbers work. The first roll Mr. Sutermeister used worked splendidly and he hasn't been able to find another roll of rubber since that works. But I think until we get a test such as that, that gives us a numerical result that you can

duplicate time after time, that correlates with the offset press, we haven't developed a thoroughly first class test.

CHAIRMAN: Mr. King: "In case paper is found to be lower in relative humidity than pressroom, how much lower is it safe to print? Can you estimate the per cent of pressrooms which are air conditioned?"

MR. KING: That is the same type of question that Mr. Reed answered on the number of pH meters a few minutes ago. I have no idea. Again, the large lithographers in most instances have pressrooms that are air conditioned, and most of the smaller ones do not.

How low you can go in relative humidity and still print is another question that depends upon the type of job, the number of times it goes through the press, and many other factors. It of course will go down to a point where static is the governing factor if your humidity drops around 30 or 35% in the paper. But if you are operating a four-color press and you put a sheet through with 30 or 35% relative humidity, it is nothing unusual to find that sheet go out of register between the first and second units. We personally don't project anything below 40.

QUESTION: I would like to have Mr. Frost tie up two of the questions that were asked him. One had to do with thickness of coating, the other with character of drying. In my experience and observation, particularly working with thick coatings, the length of drying has an effect on the coating bond. I wonder if you observed that?

MR. FROST: I haven't any real facts on your question, but I will give you an opinion. I think the more weighted coating you put on, the better chance you have to strengthen the body stock. That the longer your drying period, the less you force your drying, the greater chance you have to strengthen your body stock. And let's add a third one, the lower your sizing, the better chance you have to strengthen your body stock. Was that your question?

FLOOR: I think what you run into with the thick coating is that you strengthen your body stock but you have at the point of bonding. . . .

MR. FROST (interposing): Are you talking about thick coating; you mean viscosity or weight?

FLOOR: Maybe 15 or 20 lb., but at the point of bond you have a starvation for glue because you have the adhesive penetrating into the sheet.

MR. FROST: I have seen that. In other words, by impregnating half a sheet with adhesive you make a point of weakness where your adhesive ceases to penetrate. I have seen that occur. You've got to put it on the other side to overcome the effect. Right?

QUESTION: Would anyone on the panel care to comment on the Scotch tape test for bonding strength?

MR. FROST: Well, Mr. Sutermeister has worked out a machine that looks quite a lot like an Elmendorf tester on which you put Scotch tape on a sheet of paper, then when you let the arm go it pulls the tape off and splits the body stock. I am not personally too well acquainted with it but I think that it is quite reliable. I know it is very reliable to measure the force required to pull a film off a sheet of paper, and I think it is pretty good as a whole.

MR. RIDDELL: I would like to add a little to that. Walter A. Bublitz has worked with a similar type tester when he was with Munsing Paper Co. His findings were that there is a definite shingling factor in paper fibers. There seems to be a tendency for having fibers to sink at one end and shingle. And partially for that reason he found this method of testing was not too reliable. Providing the tape is laid parallel to the grain direction of the sheet, depending upon whether it is pulled off in machine or against machine direction. By merely reversing the direction of pull-off of the tape, in one case against machine, in one case with machine, he would get radically different results.

MR. FROST: I would like to make just a little comment on that. It seems to me that is an indication the test is pretty good, because if you put a sheet of paper through with grain one way you will get bad splitting on an offset press, if you put it through with the grain the other way you will get none. And there is an enormous difference in the resistance depending on the way the grain runs in relation to the cylinder.

CHAIRMAN: Let me caution you all that there are all kinds of Scotch tape. And you will have to take this matter up with the manufacturer to get the right one, if there is a right one. We are trying at the present time to test the removability of ink films from plastic sheets by the Scotch tape test. It is a very doubtful test, at least when you just buy any Scotch tape and try it.

QUESTION: In his talk Mr. King attached quite a bit of significance to ink wettability of the paper surface. Would he care to give us a test for that for determining the degree of ink wettability?

MR. KING: I don't know of any particular test for that. The best think I can say is I would like to go to the Vandercook proof press again which you have all set up in the laboratory for testing. That is the only thing I used, and you can compare two sheets, but to set up a numerical value, I don't believe you can do anything like that with it.

QUESTION: In your paper you mentioned printing on a varnished surface and getting your result ink dryingwise that is better than printing on a straight casein sheet. Would you care to theorize on why that was so?

MR. KING: I mentioned that there was not as much offset. There was no more offset, if as much, on the smooth sheet lacquered than there was on the straight coated sheet. The only thing that I can figure, and that is just guessing, is that I have a smoother surface to print on, and I got greater strength out of the same volume of ink in that the surface was uniformly covered. Instead of having white popping through due to the irregularity of the surface, the lacquer film was smoother and it was possible to reduce the film thickness on the sheet in that way. It is just a guess, I don't know.

MR. DANKERT: I would like to add to that, I think one of the reasons is that the lacquered surface has a certain tack, which you can't feel but it has a certain ability to lift an ink off the blanket, which an ordinary piece of paper doesn't. So in that respect there is possibility of wettability due to the material that is on the paper, and it has that receptivity because of the material that is there. It might be that another type may not be as good. Generally, a glossed surface or a varnished surface has good receptivity for an ink. You notice that a good deal on gloss printing generally. A gloss ink will have a hard, shiny surface, and you can print on it without any problem at all because it seems to have that inherent tackiness to lift. It isn't tacky in the sense of being sticky, but it has a certain surface to it that will be receptive to an ink and you will pull the ink off a blanket much cleaner than the paper will itself.

MR. FROST: I would like to make two possible suggestions that might get at that test a little bit. It would seem to me that in order to get good adhesion you have to have wettability. I think you have seen cases where after the ink has been thoroughly dry, you can take a fingernail and scratch across the halftone and leave a white streak. I think as ink wettability improves you will get an improved bonding between your ink surface after it is dry and you will have an increased resistance to scratching.

When you print a halftone high light the dot, if the sheet doesn't wet, will be in the form of a doughnut and there will be very little ink except around the rim. As wettability improves, I suspect you will find more and more room in the center of the dot where it first touched the paper. In other words, if it doesn't wet you should be able to squeeze that ink right out to the edge of the dot without leaving any trace.

Those are a couple of guesses.

CHAIRMAN: Before I turn this meeting back to the meeting chairman, I believe you would want me to comment some-

thing as follows. You and I have had a grand experience here. We have had the experience of seeing the various segments of our graphic arts industry come together and freely, unstintingly give you of their time and of their knowledge. I believe that you would want me to thank them, and to recognize that this augurs well for the future of our industry.

Coating Experiences with the Champion Coater

GLEN T. RENEGAR

It is a pleasure to present to the coating group of TAPPI our experience in the operation and problems encountered in the coating of board with the Champion coater.

In former years, we, the papermakers, were inclined to consider a sheet of board as a finished product. We would judge our product on such factors as furnish, weight, caliper, and various physical tests that would indicate strength and other physical characteristics paying little attention to its functional properties. Today a discussion of paperboard should include all of the various processes by which board and ink are brought together as the finished product in a satisfied customer's high-speed packaging plant. This is necessary because in the use of high-speed printing and packaging equipment board specification tolerances have been drastically reduced.

However, this is not my intent nor is it within my scope to do so. My remarks will be confined to the title at hand.

I would like also to state that we are not experts, neither do we know all of the answers. I will present some of the problems of machine coating in the hope that we will get some answers in our discussion period.

Approximately 15 years ago machine coated board was in its infancy. At first it gave very little competition to off-the-machine coated board. By continuing to make experimental runs, securing knowledge and know-how, it became quite evident that board could be coated successfully and more efficiently on the machine. The printing qualities of this board were equal to off-the-machine coated board which enabled machine coated board to replace it without question.

Needless to say, the boxmaker and customer had to be educated in the use of this new kind of coated board. As the problems were encountered and corrected the demands for machine coated board continued to grow. Today machine coating of board is uniquely related to cylinder machine operation rather than to coating as such.

I would like to describe briefly the Champion machine coater installation at the Philadelphia plant of CCA.

Two coater stations are used on our no. 2 machine which has six counterflow vats and one overflow vat, suction drum press with rider roll, three sets of plain primaries, suction first press bottom roll, with bare roll on top, one reverse and one straight through plain finishing press, 91—36-in. diam. stack driers, a seven-roll wet stack, and a nine-roll finishing stack. The no. 1 station is located at 26.4% of the driers; the second station is located at 53.2% of the driers from the wet end. These locations were determined by moisture content, location of draws, and a great deal of trial and error procedure. Machine speeds range from 140 to 310 f.p.m. depending on weight and caliper being made. Caliper ranges are from 0.016 to 0.035 in. thickness.

All the mixing equipment is conventional Champion equipment. Coating colors are of isolated protein bases with the per cent solids being approximately 50%.

The coating equipment itself has given very little trouble in its operation. However, production problems in machine and beater room operation were encountered which were too numerous to mention. The main problem was blowing on the driers after the second coater stations because of poor bond at the wet end; cockles also presented quite a few problems.

We soon learned that it was impossible to use bleached manila furnishes and by the addition of a clay coating to the top side have a sheet that would compete successfully with brush clay. The bleached manila furnish was proved not to be functional due to inferior benders, low density, low wax pick, rough board, and too much contrast in brightness. The function of a machine coated sheet, we feel, is to improve color, appearance, and give superior printing surfaces.

It is necessary to have formation, furnishes, points of topliner, chemicals, strength, and bender equal to the best obtainable on brush clay coated board if a satisfactory grade of machine coated board is to be produced. Machine coating of board will accentuate defects in the sheet which are not apparent on an uncoated sheet. For this reason patterns of wire and felt marks, and wet end smoothness become problems which must be eliminated. Heavy flat inks are not affected particularly, however, gloss, transparent, and pastel shade inks accentuate these patterns which in turn cause the printing to look "muddy" and give the effect of an uneven ink lay. The inkmaker can go a long way toward overcoming this condition but it is basically a board problem and must be corrected on the machine.

As most of the defects are in a sheet of board before coating, the problem is to reduce and eliminate them as much as possible. Sources of trouble can come from any phase of the manufacturing process and in this manner I will attempt to present them to you. I might also say that these same problems will arise if a high quality of uncoated boxboard is to be successfully made.

RAW MATERIALS

In the folding carton industry approximately 80% of the raw material used is wastepaper in which there is nothing that approaches the uniformity which is required of the board we are requested to produce.

We can only hope that waste dealers can and will furnish us with waste materials free from rubber bands, cork, tar paper, linoleum waste, pressure-sensitive tapes, latex bindings, and lacquer coatings.

Topliner pulps should be very carefully tested and classified for their potential use in regard to bender, brightness, formation, and dirt.

BEATER ROOM

The function of the beater room is to furnish stock for the paper machine of uniform consistency, cleanliness, sizing, brightness, uniform stock treatment, and proper furnishing of the pulper.

All boxboard machines must be able to produce both light and heavyweight sheets. To produce such a wide range of weights and calipers, roll settings of the presses, and vat circle clearances must be a compromise. For this reason if blowing, checking, poor formation, bad coverage, and poor bond are to be eliminated, uniform stock treatment procedure is required. Accurate records of furnish and degree of stock treatment must be maintained if orders are to be duplicated from run to run.

The amount of hydration necessary to good formation is determined by the types of pulp available, grade of board to be made, and the amount of stock preparation equipment available for use. When you have decided the amount of stock treatment that is needed to produce an order, every

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effort should be exerted to insure uniform stock for the machine.

Consistency regulators should be used on filler stocks, topliner stock made and refined in batches, under and backliner stocks should also, if possible, be made in batches. Each batch of top liner stock can be brought to the proper consistency and freeness before being pumped to the chest. At this point the stock should be checked for brightness, color, and dirt.

Freeness on the topliner should allow for touch-up jordaning on the stock to suit machine conditions; underliner, filler, and backliner stock do not require refining to this degree of control.

It is not practical to set up predetermined freeness standards since the characteristics of the stock and machine change, and in the final analysis the stock must be made to suit machine conditions. After a grade change has been made and the board is up to specifications, all stocks should be held as uniform as possible throughout the run.

Jordan men should make checks every hour for freeness and consistency of all four stocks, the results are recorded on a chart and at the end of the 24-hr. period filed for future reference. The results are also given to the machine tender and tour boss as soon as they have been obtained by the jordan man.

MACHINE OPERATION

Actually the machine tender's work is dependent entirely upon the uniformity of the stock supplied to him. Assuming that the stock is uniform, the machine tender must use good judgment in the distribution of the stock on the cylinders, points of top, under, and backliner carried, which, if not properly handled, will result in lumpy and poor formation. Felts must be kept clean and open for ease of water removal. As much water as possible with high velocities should be carried at all times in both the screens and vats, to insure good uniform weight distribution across the width of the machine.

Press felts should have good conditioners with enough showers to insure thorough cleaning of the felt. If satisfactory finish is to be maintained the presses should be loaded to their maximum capacity at all times.

DRIERS AND CALENDERS

Driers should be thoroughly checked for same diameter. Badly warped driers should be replaced. The lead-on driers should be run at reduced temperature to prevent fuzzing and "case hardening of the sheet." Doctors should be used on first 20 driers to insure clean driers at all times.

Coater stations should be thoroughly cleaned with a steam gun and cleaning solution every wash-up day. Hot water must be pumped through tanks, lines, and coater stations as soon as a coating run has been completed. Driers in coating area should be inspected and scraped free of clay spots. Doctor blades on driers should be inspected and changed if necessary; the same is true for the revolving rod on the coater station.

Special storage racks should be made for coater doctor blades to protect them from becoming nicked. The channel in which the rods turn must be carefully checked to be sure the rod is not too loose or too tight.

Calender stacks must be kept in first class condition at all times with doctors on all rolls where it is possible to install them.

QUALITY CONTROL

Quality control is perhaps one of the most important factors in the making of board; whether or not it happens to be machine coated has little bearing on it. A quality control program should show results to justify its existence. The results may be in less off-quality board, more production, lower furnish cost, and satisfied customers, which means more orders.

PRINTABILITY

The development of machine coating was to provide an economical way for producing a clay coated sheet with a surface which has great affinity to the ink film and perfect reproduction of halftones.

If gloss inks or overprint varnishes are used the coated surface must be able to life the ink from the plate cleanly at the same time not allowing the vehicle to penetrate into the board which would destroy the gloss of the printing.

The measurement of machine coating for printability is more critical than any other grade.

The only good test is to print the board as it is being made; for this purpose we use a Vandercook proof press on which we proof samples every hour with the same ink the carton plant will use in printing the board.

On orders where we are unable to secure the proper ink, we have a supply of inks of specific tack and gloss for checking the board for printability, gloss, and picking problems.

CURL AND MOISTURE

Curl and moisture are factors that can and do cause trouble in printing, cutting, gluing, and automatic filling machine operations. Nonuniform moisture distribution or extreme dryness is the cause of most curl problems. Lightweight sheets tend to run more flat than heavyweight boards. Kraft backs are extremely hard to control. Most curl problems can be corrected by proper control of moisture. It must be remembered that generally speaking, lithographic printing requires board with a higher moisture content than letterpress printing. However, air-conditioned pressrooms require higher moisture content levels—not litho as such.

PICKING

Picking is one of the most common complaints and may occur in two ways: coating from the bodystock, or actual splitting or pulling of the topliner stock from the filler portion of the sheet.

When particles are lifted or picked out of the coating, it indicates a lack of sufficient adhesive in the coating slurry. If the coating tends to pull away or separate from the topliner, giving what is known as a "bald pick," the coating has not been bonded properly to the sheet even though there may be enough adhesive to bond the clay particles together.

The splitting of the topliner from the main body of the sheet is where the internal bond of the sheet itself is weak. This is a problem at all times. Wax pick tests are most helpful as a quick test to determine the pick resistance of the sheet. However, they do not tell the entire story and on latex coatings are meaningless. For this reason, we feel that the Vandercook proof press is the most reliable method of testing.

BLACKENING

Champion coated sheets have a tendency to blacken more readily because the entire sheet, plus the coating, is being finished or calendered at the same time. Blackening is also caused by excessive finish, high moisture, and heavy or lumpy formation. Lightweights in particular must be watched very closely.

"Shiners" come from dirt in filler stock, undefibered stock, cellophane, or other hard substances in the sheet. They are also brought out by high finish and are more likely to occur in lightweight coated board.

FELT HAIRS

It is almost impossible to determine whether or not you are going to have felt hair trouble. I feel that there is always felt hair present on the sheet and that they come from the bottom felt. No two felts from the same supplier will be the same even though they may be "mates."

The printing department is unable to say just how many

felt hairs per sheet are allowable. They will answer the question by saying "As long as the felt hairs do not give us trouble, it is all right."

I do not say that nothing can be done to eliminate felt hairs; there are many precautions to be taken and the felt companies are more than willing to cooperate on this problem.

WIRE MARKS

I realize this is a subject that possibly has confronted everyone present. There are many things that might cause wire marks to become a problem even on machines where there had not been any trouble previously. Some of the causes are as follows:

1. Increased machine speeds.
2. Improved or better stock preparation systems.
3. Less points of topliner being used.
4. Lower vat consistency. This can be true in both the counterflow or overflow-type vat.
5. Greater differential in mold head between inside and outside of cylinder.
6. Sheet being formed too dry on cylinder.
7. Topliner furnish.
8. Too coarse mesh cylinder wire and too high knuckles on wire.

FELT MARKS

Felt marks can be due to coarseness of design, too hard twist yarn, nap too long, plastometer of press rolls too hard, and excessive weighting in primary section. All these things have a bearing on this problem. Felt companies will assist in developing a felt designed to meet your specific needs.

SPECIFICATIONS

Among the many problems encountered in the making of machine coated board, probably one of the most important, and oftentimes the hardest to solve, is the securing of adequate specifications from the customer.

Many times conflicting specifications are asked for, or specifications conflict with the method of manufacture so that a compromise in the board qualities becomes necessary. Therefore, all conflicts should be solved in writing with the customer before manufacture.

Information that may be desired should include the following:

Brightness—The brightness number must be shown on all orders.

Printing—To insure satisfactory printing qualities, the following information is necessary:

1. Number of colors.
2. Type of ink—transparent, opaque, flat, or gloss.
3. Type of coating—flat or gloss.
4. Percentage of ink coverage, whether or not it is printed over scores.
5. If varnished, the percentage of coverage and if varnish discoloration will be a factor.
6. Number of times through the press.

Style of box—The style of box must be specified, together with method of gluing; special features must be noted such as various panels, multiple folds, windows, special scoring, or any other unusual features.

Articles to be packaged—The articles to be packaged should be specified; for example, bakery goods, sugar, hardware, textiles, etc.

Bender—The board should be specified as to what is needed, example, nonbender, regular bender, and super bender.

Samples—Sample cartons should be secured if at all possible so that they can be checked for customer's specifications. If samples are not available a similar sample of board should be secured. If the order has been run before, reference to previous order number should be made.

Special requirements—Any unusual specifications needed such as water drop, curl, laminating, per cent moisture, etc. should be fully explained.

You have noted, perhaps, that I have given little time to the actual machine coating operations as such. It is my opinion and observation that the everyday operation problems from the operator's viewpoint are different on each machine. We found that when we had learned how to produce a good quality boxboard, our machine coating quality improved without any change to the equipment and color formulation.

The Role of the Board Machine Calenders in the Mineral Coating of Paperboard

HARRY C. FISHER

The mineral coating of paper and board is a most interesting subject. I approach it with diffidence in the presence of experts such as you. While any subject related to pulp, paper, and board is interesting, I have long observed that it is always possible to provoke a lively discussion about coating.

Preliminary to my discourse may I state that it is addressed particularly, but not exclusively, to that process of coating paperboard with mineral coating mixtures by imprinting, to wit, that process where the layer of wet coating mixture which has been caused to be uniformly distributed and coated in thin layer form on the surface of a rubber covered roll (usually of large diameter), is removed from it and imprinted upon the moving fibrous surface of a paper or paperboard web as the web passes through the nip formed by that and a companion roll. One or both of these rolls can serve to imprint the moving web with mineral coating mixture but it is customary to coat only the one side—the top liner side—of paperboard.

Further, may it be understood that the efficacy of the procedures and physical effects to be described is not to be disregarded where other coating processes respond to them or where, with the imprinting or other processes, they are effective when applied elsewhere than at the exact locations referred to in this discourse. Finally, it seems necessary to approach this subject from a qualitative rather than a quantitative viewpoint, as you will understand as we proceed.

The proposition presented for your consideration is that where paperboard is machine coated, as by imprinting, the moving web of board in its course from the last heated drier roll of the board machine, successively passing through the breaker stack of calender rolls, the coating unit, the coating driers, and finally the stack or stacks of finishing calender rolls, can be considered to be in a plastic condition and responsive to plasticizing influences, particularly on its surface. Further, that by means of the water boxes on the calender rolls, solutions or dispersions of substances can be applied to the web before or after coating, or both, to control the quality, appearance, printability, etc., of the coated surface and to modify the properties of the coating mixture itself.

An important reason for the imposition of mineral coating on board is to improve the surface of the sheet in appearance and physical properties and to improve its ability to receive printing inks, varnishes, etc., and other decorations. This must be done without altering the properties of the board, *per se*.

The demands made upon the quality of the mineral coating on board, as, for example, used for folding cartons, are severe. Folding paperboard, perhaps more than some papers, leads a dangerous life from the moment of its formation on the board

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machine until its ultimate use by the consumer of the substance packed in the box or carton made of it. A brief account of that life will be made to illustrate the variety of demands made upon the quality of the coated board.

Broadly speaking, the coating on board must have the right color and brightness, wax pick, dry and wet rub resistance, hardness, foldability, and resistance to marring and scuffing. Also it must be printable with flat or gloss inks and varnishes when required, and must be glueable with water vehicle adhesives. The amount of coating applied to the board must be adequate for the required purpose: there must be neither too much nor too little coating, and the finished coated surface must be adequately level, smooth, and uniform in coated thickness. Moreover, the mineral coated board must retain its identity as a board with otherwise conventional properties.

A brief recital of the successive stages in the life of a coated board in the form of, say, a folding carton, may serve to illustrate some of the requirements placed upon that mineral coating. Once the paperboard has been made and a mineral coating applied to it, all with due regard to its end use and economy, it emerges as a sheet which passes to the department where it is converted into cartons. Here the coated board must survive the rigors of printing, cutting, scoring, folding, and side seam gluing only to be subjected next to abrasive and smearing forces as the folded cartons, packed flat in bundles or containers, rub upon each other while in transit to the user of the cartons. The user feeds the folded cartons into a filling and sealing machine, operating at high speed, where it is opened up into box form, a set of carton end flaps is sealed with water base adhesive, the merchandise is loaded in, the other flaps are closed and sealed, and the filled cartons are loaded into containers for shipping to the final consumer. En route to the latter the coated surfaces of the carton board again have opportunity to punish each other by rubbing together.

Thus, it seems clear that the interposing of a mineral coating between the fibrous board surface and the printing, adhesive, and any other substances used to form the carton, which latter materials otherwise could contact the fibrous surface directly, places a great responsibility upon that coating. This is not to suggest that the mineral coating on paper, and on boards for purposes other than cartons, is less stringent than for cartons, but it does illustrate the great demands that cartons do place on the mineral coating on board.

The weight-area-thickness relationships of paperboard commonly accepted by the industry place a limitation upon the extent that calendering alone can be relied upon to finish the mineral coated surface. It is possible, of course, to apply a mineral coating to board by a suitable method and then by heavy calendering, or even super calendering, to finish that coating to smoothness and gloss at the expense of the thickness of the board along with the chance developing of imperfections in the coated surface arising from foreign materials interior of the sheet. However satisfactory such a coated surface may be it would seem desirable to achieve or at least to approach its quality without having to accept along with it undesirable effects on the board itself. This it is possible to do by the judicious use of the regular board machine calender stacks, taking advantage of the so-called "plastic" condition of the fibrous web as it passes from the breaker stack of calenders through the coating and drying units and finally the finishing calenders.

It is our experience that if board is made and stored in the reel for several days before it is passed through the imprinting type of coater and the calenders immediately following it, that the quality of coated surface is different than when the board, freshly made, passes without pause through that coater and the finishing calenders immediately following it. Other conditions being equal, the former coated surface lacks the qualities of continuity, smoothness, pliability, and good "feel" commonly associated with a good mineral coating. Moreover, printing thereon suffers accordingly. An additional period of time remaining coated, in the reel, before being given the finishing calendering treatment seems likely to further decrease the quality of coated surface.

It is desirable to define the term "plasticize" as used in this discourse. Herein "plasticize" means to prepare the fibrous surface of the paper or board web for the receiving of an imprinted or equivalently applied mineral coating mixture by calendering the moving, usually hot, fibrous web on a stack of board machine calenders situated immediately after the last heated drier roll of the paper machine (the "breaker" stack), that calendering being done in the presence of a water solution or dispersion of substances suitable for being deposited on and mechanically worked into and onto the fibrous surface there to form a more or less continuous minute coating or film simultaneous with the smoothing and compacting of the web surface. "Plasticize" further recognizes that value to the quality of coated surface which may result where the calendering operation preceding the coating step is performed in the presence of water only or water containing considerable amounts of suitable substance dissolved or dispersed therein. It is further recognized that in the rapidly moving web of board the quality of plasticity persists on to and through the stack or stacks of finishing calenders.

Substances found suitable for use in the water applied to the web on the breaker calender stack include starches, polyvinyl alcohol, sodium carboxymethyl cellulose, proteins, etc., alone or in suitable combinations, and preferably in concentration as great as practicable if the utmost in plasticizing effect is to be obtained. A common quality of them is their substantial inertness to the fibrous web although there is no objection to chemical activity between a plasticizing substance and the fibrous web if the plasticizing quality prevails. The amounts of plasticizing substance permissible in the water are limited, in a practical way, to an amount insufficient to cause sticking, picking, and like troubles on the calender rolls, and to an amount insufficient to modify too much the properties of the layer of mineral coating itself. The latter limitation will be discussed later.

The effects on the coated board of the plasticizing action performed on the breaker stack of calenders increase, qualitatively, through several stages, starting where the calender rolls are run dry and continuing where plain water is used, and where the water contains plasticizing substances in increasing amounts; further, there are differences between plasticizing substances, the effects of polyvinyl alcohol and starch bracketing that of carboxymethyl cellulose, for example.

What is the result of using a plasticizing substance and plasticizing action in the process of making an imprinted mineral coated board? The result is a uniform, smooth, thin layer of mineral coating with controlled printing, varnishing, and gluing properties. Not only is the moist fibrous surface of the web mechanically worked and smoothed by the nip action of the heavily loaded rotating calender rolls but simultaneously the plasticizing substance becomes well distributed over and into the fibrous surface where it helps bind the subsequently applied layer of mineral coating substance to that surface and also is absorbed up into the coating itself, the properties of which are altered thereby.

Actually, the plasticizing step is but one of five essentials for the production of high quality mineral coated board, comprising: (1) paperboard of high quality must be made, (2) mineral coating mixture of proper quality must be made, (3) the board must be "plasticized," (4) while the surface of the board remains under plasticizing influences the coating must be applied to it and dried, and (5) the coated board must be calendered. The performing of steps 4 and 5 during the persistence of the plasticizing effect is most helpful in producing a high quality mineral coated surface on the board.

As stated earlier a qualitative rather than quantitative

approach is used in this discourse. The presentation of data to correlate plasticizing and calender treatments of board with the properties of its mineral coated surface is postponed to another time. Much of the information herein was obtained from the evaluation of the quality of printing on the coated surface with inks of oil and/or resinous vehicles. Certainly, a mineral coated surface that does not receive printing ink properly is of no value on a carton or display card or the like regardless of its wax pick, rub resistance, water drop, etc.

A threefold comparison of the effects of breaker calender stack plasticizing treatments on ink printing—in this instance, letterpress—on the mineral coated surface of board is obtained when (1) the breaker stack is run "dry," (2) a strong plasticizing treatment as of PVA is used on that stack, and (3) a mild plasticizing treatment as of PVA in lesser concentration is used along with a penetrating or wetting agent, for example, butyl carbitol or Emulphor EL on that stack. In each instance the same mineral coating was imprinted on the same board, and other conditions were equal. The resultant coated boards were proofed with gloss and flat letterpress inks and varnish.

A summary of the ink-printed results shows that the dry finish board (1), despite its good coated appearance, prints poorly, all inks showing a tendency to soak in to give a spotty uneven appearance. With the strong plasticizing treatment (2) the printing is even, gloss inks "gloss" satisfactorily while flat inks are uniformly flat. Should a flat ink tend to gloss because the particular plasticizing substance used makes the coated surface more ink-resistant a compromise can be devised. With plasticizing treatment (3), including a wetting and penetrating agent, the flatting qualities of the printing ink are emphasized.

If the process of calender coloring board is combined with the plasticizing action on the breaker stack of calenders as by adding dyestuff to the water solution of plasticizing substance the subsequently imprinted mineral coating will become colored or tinted of itself in addition to being imposed upon a calender stained fibrous surface. Generally the latter is colored more strongly than the former, the final colored appearance of coating being a composite of both. By carefully scraping mineral coating off the sheet the coating's colored condition, *per se*, is readily demonstrated. As in the instance of the plasticizing substances some of the dyestuff is absorbed up into the body of the coating mixture.

Dyestuff for this use must be selected to be compatible with the pH of mineral coatings. Acid dyes like Eosine, Tartrazine, and Erioglaucine give evenly colored mineral coatings and blends of them produce coatings of green, brown, etc. hues with alkaline coating mixtures; basic dyes give mottled coatings.

Attention now is directed to the role of the board machine finishing calenders which are the final step in the process from the breaker stack, through the coater, the coater driers, and the finishing calenders. It is believed that they produce a superior finishing effect on the coating when some plasticizing action is residual in the coated web when it passes through the finishing calenders.

The decision whether to calender finish the mineral coated web of board dry or in the presence of water is dictated by the nature of the adhesive in the mineral coating. Naturally, with a water-soluble binder like plain starch in the coating on the web of board, use of water in the calender box results in a redissolving of the starch with picking and sticking of coating to the calender rolls and destruction of the coated surface. Conversely, if the adhesive of the coating is truly water-insoluble, use of water in the calender boxes causes no harm but neither does it do any good. To obtain the maximum value from wet calendering of the coated surface a happy balance must be found between enough softening and dissolving of the adhesive to permit the coated surface to be deformed and reformed to the desired smoothness in the nips of the steel calender rolls and insufficient to permit the complete dissolving and destroying of the coated surface. A useful approach to this condition is made by blowing steam onto the coated sheet as it is calendered.

A high degree of smoothness and considerable gloss of calendered coated surface without deleterious effect on it or on the operation of the calender stack where starch, not insolubilized, is the adhesive of the coating, can be obtained by use of a proportioned solution of alcohol in water on the finishing calender stack. Here the water softens the coating while the alcohol (alone) has no effect on it; thus, in the alcohol-water solution the alcohol controls the amount of dissolving of starch adhesive with consequent sticking to the calender rolls, that can occur. In a typical calender solution, 60 volumes methanol with 40 volumes of water is effective.

In another procedure it is found possible, at least to limited degree, to calender finish the starch-mineral coated sheet (starch not insolubilized) to high smoothness with a water solution of "slippery starch," the latter being a high concentration solution of low viscosity starch containing, in addition, such a material as slippery elm. It is curious that this procedure works at all!

Where the adhesive of the coated surface is not dissolved or softened by water, water on the finishing calenders is ineffective in smoothing and glossing the coated surface. In this instance the application of a water solution of starch, PVA, carboxymethyl cellulose, etc. to the coated surface by the water boxes of finishing calenders reduces the porosity of the coated surface and its absorptivity to printing inks without much change in its appearance.

In coating processes where the short life of resin-insolubilized starch-mineral coatings mixtures is likely to cause trouble on the coating machine, the board machine calenders can be used to prevent the trouble. Broadly speaking, three elements are involved, the starch-mineral coating mixture, the resinous substance such as melamine or urea-formaldehyde, and the catalyst to effect its cure. As is well known, these three elements, properly compounded, produce a mixture which, applied to paper or board, rapidly set to a water-resistant, wet-rubproof coating. The problem is how to prevent the mixture from setting prematurely and is acute with coating processes where the wet coating mixture spread out in thin film form before it contacts the fibrous surface, has opportunity to dry rapidly on the coater mechanism itself.

Use of the board machine calenders in one of three different ways solves the problem. In the least practical way, a catalyzed water solution of the resin is applied by a calender water box on the breaker stack of calenders to the surface of the moving web of board and the wet starch-mineral coating is imprinted on it whereupon there is sufficient absorption of resin up into the layer of coating to make it water and wet-rub resistant after the coating has been dried, heated, and aged. The objection to this way is the short life of the catalyzed resin solution in the water box. A plasticizing substance can be included in the resin solution.

The other two ways are highly practicable and complement each other. In the one, the resin is included in the starch-mineral coating mixture and the catalyst, say ammonium chloride, applied along with plasticizing substance on the initial—the breaker—calender stack. In the other way, the resin is applied by breaker calender stack along with plasticizer and the catalyst included in the coating mixture. In both instances the co-acting of the starch of the coating mixture with the resin and catalyst insolubilizes the imprinted mineral coating on the board by the absorbing up into the layer of coating from the calender-treated surface of the web of board the remaining reactant required to insolubilize the starch adhesive of the coating.

There is a logical but curious difference between the coated boards of the last two instances. The sheet having the calender resin treatment directly on its surface under the

mineral coating is wet-rubproof on that surface, giving rise to a broke recovery problem where the insolubilizing treatment has been strong. In the beater the fibers are removed from the board leaving a slimy layer of coating. Where the resin has been mixed into the coating there is no broke recovery problem of that nature.

In an extension of the water-insolubilizing of starch-mineral coating processes, just described, the board machine calenders can be used to make colored mineral coatings. First there is the obvious step of substituting finely divided mineral pigments or lakes for more or less of the customary clay or other mineral matter of the coating and proceeding in one of the ways, described above, with resin and catalyst. Again, a suitable dyestuff can be employed in the starch-mineral coating mixture, relying upon some complex reaction between it, resin and catalyst, and perhaps the starch, to color the coating to desired hue by precipitating or fixing therein a colored complex. Here, as well as where colored pigments are substituted for white minerals, increases in the adhesive-minerals ratio and in the amount of resin used over that customarily employed with uncolored coatings are needed to achieve high degrees of water insolubility or wet rub of coating. And, of course, the color of coating can be controlled further by calender application of suitable dyestuff applied to the fibrous surface of the board web before it is coated, and by calender application of dyestuff over the coating on the web.

Highly polished steel calender rolls and water solutions of acid catalysts would seem to be incompatible on a paperboard machine and certainly the corrosion problem arising therefrom cannot be ignored. Even with calender rolls chromium plated or made of corrosion-resistant metal there is need for alleviation of the corrosive effect of catalyst. In an interesting method of alleviating the corrosion where ammonium chloride is used in the breaker stack solution to catalyze the paper surface of the board web before the layer of starch-mineral-resin coating mixture is applied thereon, sufficient ammonium hydroxide is added to the breaker stack solution to make it alkaline and less corrosive, in which condition it remains on the calender stack. Then, when applied to the hot web of board by the water box of the calender stack the excess ammonia volatilizes off and the ammonium chloride recovers its acid condition and ability to catalyze the resin.

Corrosion inhibitors immediately come to mind for use in acid calender solutions. Their efficacy, as a class, is not doubted but unfortunately, many of them are highly colored substances and some are odorous, making them unavailable with most coated paperboards where brightness of white color and freedom from odor are requirements. Formaldehyde is of some value. Much remains to be learned about inhibitors in this connection.

Board machine calenders are useful, too, for the insolubilizing of mineral coatings made with a protein adhesive, as of casein or soy protein. Although such coatings are intrinsically more water resistant than with starch there are limits to the extent that water alone can be used on the calenders to finish the surface of the coating. The well-known ability of the family of formaldehydelike substances—formaldehyde itself, glyoxal, etc.—to insolubilize the casein of a mineral coating mixture is of limited utility where the short life of the coating mixture containing one of them is aggravated by any method of coating which gives it opportunity to dry rapidly before or as it is being applied to the sheet. The problem, then, of insolubilizing the protein-mineral coating resembles that with starch.

Once more, the problem of preventing premature hardening or insolubilizing of the coating mixture—this time containing protein instead of starch—is solved by performing the coating operation with mineral coating free of any hardening or insolubilizing ingredient. Then, the protein is converted into an insoluble substance by reacting it with a suitable metallic salt—aluminum sulphate in the form of papermaker's alum being useful. The board machine calenders are usable for this purpose in two ways.

First, the plasticizing solution on the breaker stack of calenders has added to it and dissolved therein a rather small content of alum, and this solution is applied to the surface of the web of board in the customary manner. When a couple of seconds later, the thin layer of proteinaceous mineral coating mixture is applied over the alum treated surface an insolubilizing reaction occurs between it and the proteinaceous materials thus making the layer of coating water resistant outwardly from the paper surface. Similarly a dilute water solution of alum can be applied to the coated surface by the water box of the finishing calenders whereby the insolubilizing reaction on the protein of the coating proceeds inwardly from the outer surface of the layer of coating. Although the degree of insolubilization of coated surface obtained from the breaker stack treatment alone is considerable, even large, that obtained by finishing calenders is much greater and is ample, alone, for most uses of the coated board. In one sense, the insolubilizing actions, performed as described, "case harden" the layer of coating from either side.

The synergistic action of formaldehyde or formaldehydelike compounds—e.g., glyoxal—and alum can be utilized in the above procedures by dissolving the two substances together in the same calender solution used to insolubilize the protein of the coating. On the finishing stack, to the extent that solutions of decreasing concentrations of glyoxal and/or alum, for example, produce sufficient water resistance of coated surface without it picking on the rolls, or dissolving off excessively, increased smoothness of calendered mineral coated surface is obtained by decreasing the concentrations until the coated surface "milks," which is to say dissolves and softens just enough to enable the calender rolls to be more efficient in smoothing the coated surface.

The relative merits of using aldehyde substances versus metallic salts when insolubilizing protein coating are debatable. Certainly the use of an aldehyde to insolubilize the protein throughout a layer of coating is a different thing than insolubilizing the outside surfaces of the coating, as by a metallic salt or by the aldehyde substance. Then, too, the questions arise whether an insolubilized surface is better with alkaline or acid reaction and whether one prints better than the other with inks.

Where substances in the breaker calender stack solution discolor it and consequently reduce the brightness of calendered surface of board and of mineral coating over it the addition of whitening and opacifying substances to the calender solution, if practicable, if useful to reduce said discoloration. From this flows the idea that a definite mineral coating operation can be performed on the calender stack by loading its calender solution of PVA, starch, CMC, etc., with a modest content of finely divided white mineral such as titanium dioxide or titanium-calcium or barium complex pigment, perhaps along with clay. Suffice it to say that the coating operation thus practiced appears to have but limited practicability although a decided whitening and masking effect can be produced on the board's surface for a while. The trouble encountered after a short period of operation with a calender solution loaded, in addition, with finely divided mineral matter, is that minerals settle out of the solution, the mixture streaks and dries on the calender rolls, the calender rolls are "ground down," etc.

"Chalking" needs no introduction to people engaged in the practice of coating. A common defect of a coated surface is chalking when it is rubbed against itself or another surface. As against the condition where chalking occurs because of a deficiency of adhesive for the mineral matter of the coating the presence of too much adhesive may harden the coating and make it abrasive whereupon when rubbed against itself particles of coating are abraded off or a surface rubbed with

the hard coating is scratched. In any event, the end result is undesirable.

If, for some reason or other, it is not feasible to correct chalking by adjusting the adhesive in the coating mixture the finishing calenders offer means of lubricating and toughening the coated surface thus to reduce or eliminate it. Whereas an application of ordinary wax—e.g., emulsified wax size—to the mineral coated surface by water box of a finishing calender stack has some utility for that purpose, most likely the water-repellency thus imparted to the surface will lead to difficulties in gluing it with water vehicle adhesives.

The polymerized ethylene glycols, particularly those of high molecular weights, popularly referred to as water-soluble waxes, perform nicely in the calender stack water box over a mineral coated surface where the application of wax toughens and lubricates the surface without seriously changing its functional water receptivity.

A finished mineral coated surface of carton board must be receptive to water vehicle adhesives; when the coating has been insolubilized this means that its surface must remain wettable by and absorbent of water to permit the adhesive to "take hold." In the manufacture and use of folding cartons, particularly, the ability of the carton board to respond rapidly and with permanent result to water vehicle adhesives is a prime essential. Carton side glue joints are formed at high speed with a very small time of dwell under a modest pressure while "setting up," and the top and bottom carton flaps fare no better. Therefore, the use of board machine calenders to preserve the gluing property of a mineral coated surface is a valuable use.

Additional uses of board machine calenders may be made simultaneously with those discussed above. For example, insect repellency may be imparted to the board and/or coating by including pyrenones (a mixture of piperonyl butoxide and pyrethrin) in a calender box water solution, preferably on the breaker stack under the mineral coating if it is to be applied to the coated side of the board. Similarly, a suitable mold-proofing ingredient such as phenylmercuric acetate can be employed in a calender solution. These applications can be extended to the back of the board, too.

Calender treatments unavoidably cause loss of brightness of the white mineral coated sheet. However, the losses are not so high as to make use of calender treatments impracticable and they can be compensated for by equivalent increase in brightness of the base stock, increased opacity and brightness of mineral coating mixtures, etc. The following table, exemplary only, shows brightness changes of board, coated and not coated, due to plasticizing solutions used on the breaker calender stack.

Brightness Changes of Board, Coated and Not Coated, Caused by Use of Breaker Stack Calender Solutions

	G.E. brightness of board surface		
	Not coated	*Coated but before finish calendering*	*Coated after finish calendering*
Rough board surface leaving breaker calender stack, dry finish	58.0	67.2	66.0
Board surface leaving breaker calender stack with water finish	56.5	67.0	65.8
Board surface leaving breaker calender stack with starch finish[a]	56.4	67.1	65.4
Board surface leaving breaker calender stack with PVA finish[b]	56.1	67.0	65.5
Board surface leaving breaker calender stack with CMC finish[c]	56.5	67.2	64.7

[a] One calender nip application of chlorinated starch solution of 3½% concentration.
[b] One calender nip application of PVA solution of 5% concentration.
[c] One calender nip application of CMC solution of 3% concentration.

The amounts of plasticizing substances deposited on the paper surface of board by the water box of the breaker calender stack are small which makes their favorable effect on the mineral coating even more impressive. One water box will apply, say, 7 to 10 gal. of calender solution per ton of board, neglecting differences due to thickness of board, varying absorptivity of its surface, etc. With a board 0.016 in. thick and measuring 29,000 sq. ft. per ton, and consuming 10 gal. of calender solution containing 5% by weight of plasticizing solids per ton, the amount of solids deposited on the surface of the board is 0.1433 lb. per 1000 sq. ft., certainly a small quantity.

The control of wax pick values of coating by calender treatments of the web, before or after coating it or both, is desirable and of practical utility but it has the basic limitation that the application of material sufficient in quality and quantity to significantly alter the wax pick is quite likely to change the printability of the coated surface with ink. It is entirely satisfactory to formulate a coated board of desired printing quality in which the calender treatments are an important element contributing to wax pick but in event a deficiency in wax pick is found in the coated sheet—cause unexpected or unknown—one's desire to cure it by a drastic calender application of something or other must be tempered by an awareness that the printing quality of the coated surface may be altered thereby.

He who mineral coats paperboard is interested in the appearance or pattern of the final finished coated surface. He knows that often the layer of coating is very thin, that it may follow the contour of the surface of the board, and that the particular mode of imposing the wet coating mixture upon the board's surface may give it a distinctive appearance at some stage of the sequence of steps in its manufacture. Therefore, he takes inventory of the means at his disposal to control the quality of the final finished coated surface without changing the normal quality of the paperboard upon which the coating is imposed.

He finds that the means at his disposal include such things as high quality papermaking on modern board machines, the proper formulating and mixing of mineral coated mixture, and the imposing and drying of them upon the paper surface, and the use of board machine calenders to prepare the paper surface of the board for the reception of the coating and for the finishing of the imposed coated surface.

He concludes that while no one means at his disposal is more essential than another, the board machine calenders to play a very important role in the machine coating of paperboard.

Considerations in the Installation and Operation of High and Low Solids Coaters in a Board Machine

A. W. POMPER

In order to present considerations in the installation and operation of high and low solids machine coaters in a board machine, it will be necessary to discuss the theoretical as well as the practical aspects. I shall describe two types of machines—the Microjet as a low solids coater operating on the

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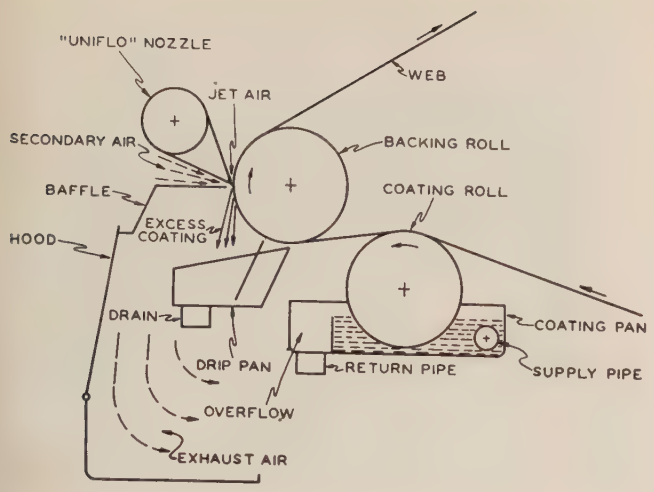


Fig. 1

principle of controlled removal of coating, and the Syncroset as a high solids coater of the metered application type.

MICROJET

The air knife or "Microjet" principle is illustrated in Fig. 1. A slight excess of coating is applied to the web by means of an applicator roll rotating in the supply pan at a controlled speed relative to the web. This excess is removed by a high velocity jet of air striking the surface at an angle of about 45°. The excess is drained from the blow-off pan, mixed with fresh coating, and pumped back into the supply pan. The coating weight is regulated by the velocity of the air jet striking the web, and is relatively unaffected by other variables assuming the viscosity and percentage solids of the coating are held constant (which can be easily done with accurate mixing and a circulating coating system). For any set of conditions, coating weight will be different for paper of considerably different absorbencies, especially at lower speeds. The amount of excess coating applied by the applicator roll has a negligible effect on the finished weight. Observation of the "Microjet" in operation reveals the reason for this phenomenon. Most of the excess coating is blown off somewhat below the point at which the jet strikes the web, being easily removed by the volume of lower velocity air of the expanded jet. The remaining coating film can be metered only by the application of the higher shearing force of the high velocity jet at the point of impingement. The web speed has a small effect on the coating weight. Tests have shown that for a 300% speed increase, the increase in coating weight is only about 20% (from 50 to 200 f.p.m.).

The velocity of the jet striking the web and the coating weight can be controlled by varying the air pressure or by changing the distance from the nozzle to the web. As the velocity at this point is also affected by the slot opening, a nozzle with closely spaced adjustments is provided for coating uniformity, although once set to a uniform opening, this adjustment does not have to be changed. Since air velocity from a nozzle of any constant efficiency is dependent on the pressure alone and not on the slot opening, it may seem strange that a uniform slot is needed. The reason for this requirement is clearly shown in Fig. 2. This is a graph of air velocity and impact pressure versus distance from the nozzle. All curves are at 3 in. of mercury static pressure. Curve A′ shows the velocity in feet per second. Curves A, B, and C are of impact pressure as measured by a pitot tube. The impact pressure, which is proportional to the square of the velocity,

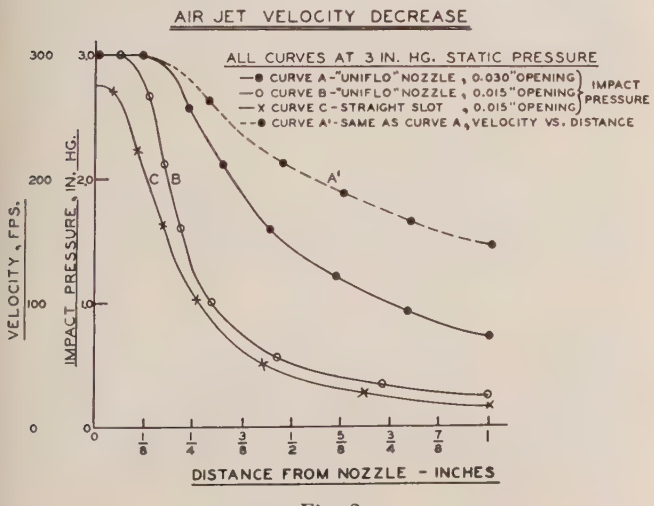

AIR JET VELOCITY DECREASE
ALL CURVES AT 3 IN. HG. STATIC PRESSURE
CURVE A-"UNIFLO" NOZZLE, 0.030"OPENING
CURVE B-"UNIFLO" NOZZLE, 0.015"OPENING
CURVE C-STRAIGHT SLOT, 0.015"OPENING
CURVE A'-SAME AS CURVE A, VELOCITY VS. DISTANCE
IMPACT PRESSURE
VELOCITY, FPS.
IMPACT PRESSURE, IN. HG.
DISTANCE FROM NOZZLE - INCHES

Fig. 2

Fig. 3

is the actual representation of the force exerted by the air jet on the web. Curves A and B are plotted for the high efficiency "Uniflo" nozzle, set at 30 mils opening in curve A and 15 mils opening in curve B. The impact pressures are identical, regardless of opening, at the exit from the nozzle. However, at $^3/_8$ in., which is the approximate point of contact with the web for a $^1/_4$ slot-to-web distance and a 45° angle, the impact pressure from the 30-mil slot is considerably greater than that from the 15-mil slot. Curve C shows the impact pressure from an earlier nozzle design—a straight slot rather than a true converging nozzle shape—indicating a considerably lower efficiency which produces lower air velocity at any distance.

The gradual decrease in impact pressure, or metering force, with distance (as compared to other metering methods) is re-

sponsible for the Microjet's ability to produce good coverage on a rough surface with minimum coating weight. The high points are not scraped clean as with a knife coater, resulting in good coverage with 50% less coating on some rough surfaced webs.

While most of the excess coating is removed as a liquid, some of the coating metered by the high velocity jet is atomized into fine particles. The particle-laden air must be controlled to prevent build-up of the coating on the nozzle, causing streaks. A baffle is attached to the nozzle for this purpose, utilizing the flow of secondary air induced by the high velocity jet to flush away the particles and keep the nozzle thoroughly clean. Figure 3 shows a shadowgraph of the nozzle, baffle, and backing roll. The air jet can be clearly seen with this type of photograph. The irregular line is a thread being drawn in by the secondary air, illustrating the flushing action of this induced air stream. Figure 4 shows the construction of the nozzle mounted in a test stand. In a commercial installation, air enters from both ends to assure uniform pressure across the entire slot. The slot adjustments on the top lip are spaced at $2^1/_2$-in. intervals and recessed. The lower blade of the nozzle is entirely free of obstructions to prevent turbulence in the secondary air. The nozzle is mounted on the

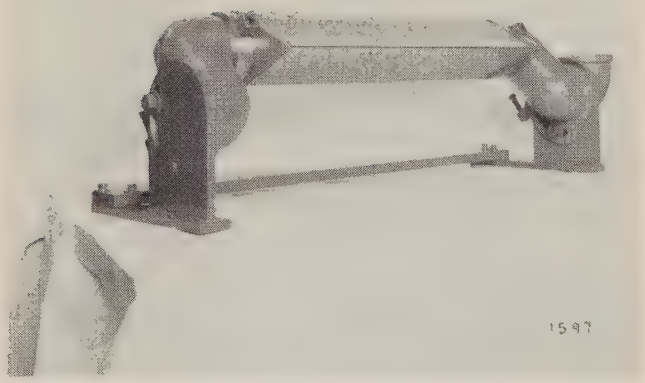


Fig. 4

axis of the tube, so that it can be pivoted away from the backing roll for cleaning or for threading the web.

The next factors to be discussed are the location of the coater in the board machine, the space involved, drying requirements, power consumption, coating solids, coating weights, and ease of operation.

A typical Microjet coater for board machine installation is shown in Fig. 5. A heavy steel frame supports the nozzle, backing and coating rolls, pans and hoods, and a pivoted roll assembly to bring the web in contact with the coating roll without materially affecting web tension. This unit has an 18-in. diam. backing roll, 14-in. diam. coating roll, and 12-in. diam. idler rolls. The over-all dimensions are approximately 8 ft. long by 6 ft. high. The widest machine built to date is for a 150-in. web, although it is practical to coat over 200 in. This form of the Microjet is generally installed in the basement below the board machine to avoid removing drying rolls or lengthening the entire line. For installations where no basement is available the new design of Microjet can be used, which is simpler and much more compact requiring only about 4 ft. in height by about 3 ft. in length. Access of at least 2 ft.

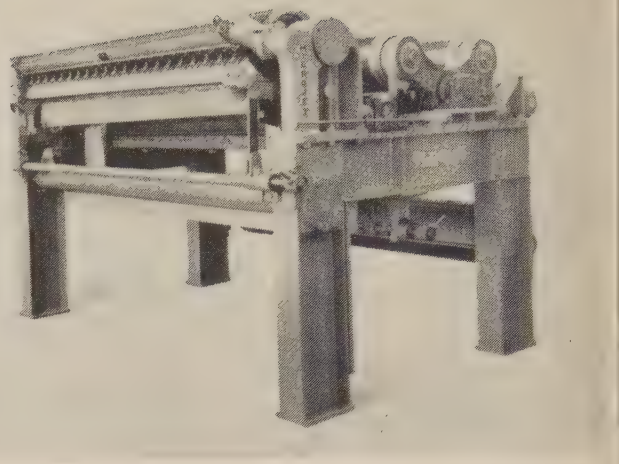


Fig. 5

along the front of the machine must be provided for ease of operation in either case.

The centrifugal blower for nozzle air supply and the circulating coating system can be located remotely.

The Microjet should be installed near the dry end of the board machine, as shown in Fig. 6. Less than 10% moisture in the sheet prior to coating is preferable, as higher moisture content will increase the drying required to prevent coating from picking off on the drying drums. A breaker calender stack preceding the coater will present a smoother surface for good coverage with somewhat less coating weight. One of the advantages of a basement location for the Microjet, aside from space considerations, is the long web travel available before the coated surface strikes the first drying drum. Either air or radiant drying can be provided in this span. Both produce good results. The application of one or the other will be influenced by cost, available space, and safety requirements, as the radiant heating methods can transmit more B.t.u.'s. per minute than the air driers, but present a possible fire hazard and do not assist drying by air removal of moisture.

It is practical to operate the Microjet with clay-casein coatings at solids up to or slightly over 45%. Dry weight with this coating and 4 p.s.i. air pressure would be about 4 lb. per 1000 sq. ft. depending on the coating viscosity. It is generally not advisable to use considerably higher air pressures, because of increased power consumption, although the nozzle is designed for use at 6 p.s.i. A general figure for minimum coating weight with 45% solids would be about 3 lb. per 1000 sq. ft., again depending on the coating viscosity, which should be maintained as low as possible. For the best coating formulation for either the Microjet or Syncroset, I would suggest contacting any of the well-known adhesives manufacturers, or referring to the TAPPI Monograph No. 9 on adhesives for general information.

In any case the exact weight obtainable for any type of board and coating at any speed can be determined by laboratory tests before installing a machine to do the job. By using a lower solids (and lower viscosity) coating, the weight can be

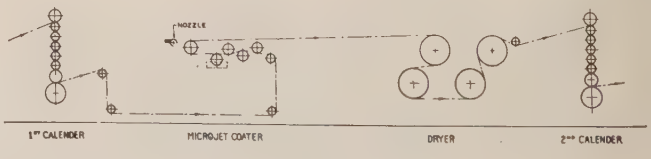


Fig. 6

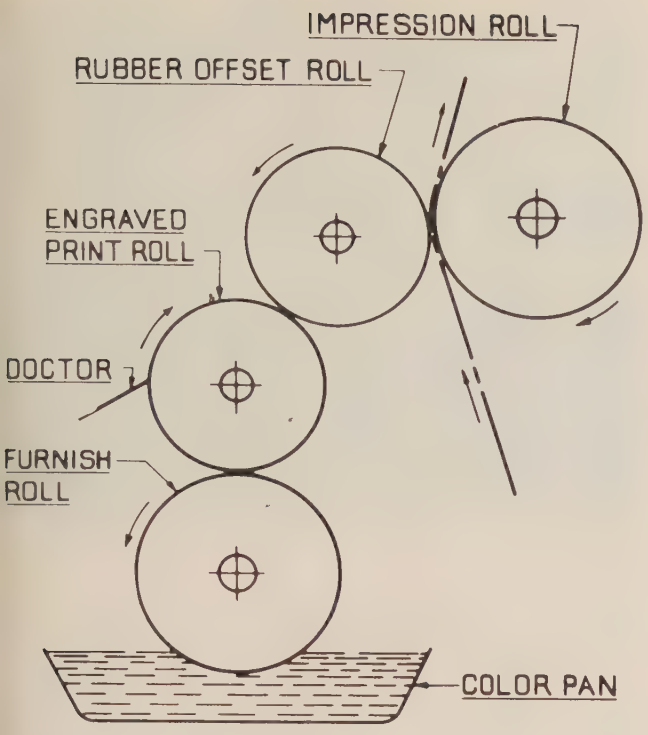


Fig. 7

easily reduced well below 4 lb. per 1000 sq. ft. at 4 p.s.i. air pressure. The maximum coating weight is well over 10 lb. per 1000 sq. ft. with the Microjet although drying problems make this impractical on a board machine.

The power required to drive the backing roll is negligible. In fact, this roll can be idled in a board installation, since it is ball bearing mounted and can be easily driven by the web. The coating roll requires slightly more power as it is rotated at less than half web speed. This roll must have a variable speed drive to control the amount of excess coating applied, as discussed earlier. Five horsepower is more than enough to drive this roll on a 100 in. machine operating at 400 f.p.m. Most of the Microjet power consumption for higher viscosity coatings is for the nozzle air supply. A multistage centrifugal blower is used for this purpose, driven at 3600 r.p.m., and controlled by a blast gate in the inlet or discharge line. Knowing the pressure required to produce the desired coating, the blower capacity is determined by means of the formula:

$$V = 4.4L\sqrt{P}$$

where V is the volume in cubic feet per minute, L is the length of slot in inches, and P is the pressure in pounds per square inch.

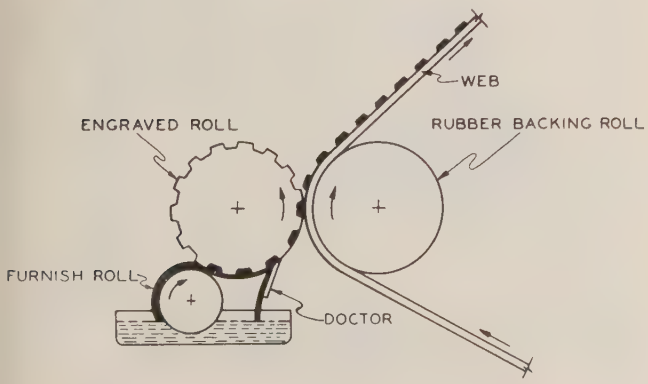


Fig. 8

This formula was developed for use with a high efficiency nozzle operating at a 30 thousandths slot opening. For a 100-in. coater operating at 4 p.s.i., the volume as determined with this formula is 880 c.f.m. A blower delivering this air requires a 30-hp. motor, considerably more than the power required to drive the rolls.

The Microjet is a versatile coater that requires little upkeep as the coating is metered by a jet of air which can't wear out. The filtered air, although moving at high velocity, has no noticeable abrasive effect on the hard chrome-plated nozzle lips. Considerable difficulty had been experienced in the past with build-up of the atomized coating particles on the nozzle and baffle, causing streaks in the coating. This problem has been solved by the development of the high efficiency "Uniflo" nozzle which has no projections to cause the secondary air turbulence that permits particle build-up, and by other improvements in the exhaust air system. Regardless of coating weight, the Microjet will not produce the objectionable pattern inherent in most roll coaters at high weights.

The high flexibility coupled with dependability of this coater has made it very popular with converters, operating at speeds up to 1000 f.p.m. with adequate air drying. The relatively low solids have prevented its use on high-speed paper machines although the drying problems are being studied, and

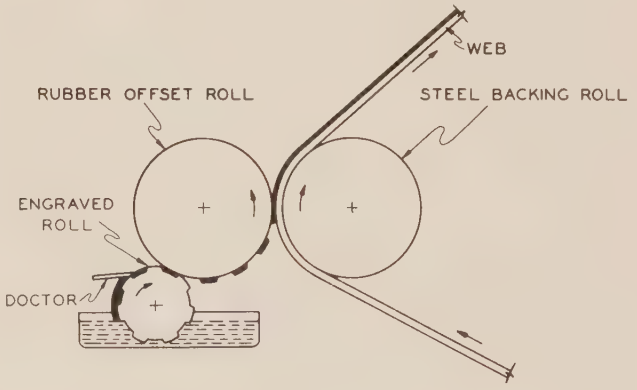


Fig. 9

the Microjet may be applied to paper machines in the future, especially with lower viscosity coatings. For board machines it is a practical coater, producing a uniform sheet at a wide range of weights.

SYNCROSET

The gravure-offset or "Syncroset" principle is one of metered application of coating rather than controlled removal as in the case of the Microjet. The operation is illustrated in Fig. 7. A furnish roll rotating in a pan supplies coating to an engraved roll. The engraved roll is doctored by an oscillating doctor blade, and transfers the coating from the engraving to a rubber offset roll, which in turn deposits the coating on the web against a steel backing roll.

The offset principle is used to produce complete coverage, free from engraved roll pattern. Figure 8 shows the effect obtained by direct engraved roll coating. The tops of the engraving are free of coating and are pressed in contact with the web. The coating is transferred as dots from the depressions, leaving a pattern of coated and uncoated paper. With the offset method (Fig. 9), the dots that were formed on the web with the direct method are produced on the offset roll instead. Since the web passes under pressure between the backing roll and the offset roll, the coating is squeezed out into a continuous film at the nip. Too light a nip pressure will allow the dots to pass through without being flattened out. Of course, the film splits as it leaves the nip, most of the coating adhering to

the web and part remaining on the offset roll, and with too heavy an application it may split in ridges, producing the objectionable pattern which is inherent in coaters where the surface of the applicator roll travels in the same direction as the web.

If coating weight is to be controlled by the engraved roll, it is important that no coating is held back by the nip between the offset roll and the web in contact with the backing roll. Under certain conditions, the pressure required for proper application may prevent some of the coating from passing through, as evidenced by a puddle forming at the nip. In order to eliminate this tendency, large diameter offset and backing rolls are used.

The Syncroset is not as flexible as the Microjet, as coating weight can be varied only slightly (by varying the percentage solids) with any one engraved roll. The flexibility is not as important a consideration on a board machine as is tonnage of accurately coated board, however. Most important, the Syncroset can apply coatings of 65% solids as contrasted to the Microjet's limit of 45%. This means less space and less heat required for drying, although some air drying is advisable at speeds over 300 f.p.m. Figure 10 shows a typical Syncroset for machine coating. This unit has 24-in. diam. offset and backing rolls, a 14-in. diam. engraved roll, and a 12-in. diam. furnish roll. Nip pressures are adjustable up to 100 p.s.i. Figure 11 shows the drive side of a Syncroset.

The installation of the Syncroset is also near the dry end of the machine, preceded by a breaker calender stack. Overall dimensions are about 6 ft. long by 8 ft. high, which means that it can be readily installed in line with the board machine, by removing a few drying drums or by extending the machine slightly.

At 65% solids, coating weights of from 2 to 3 lb. per 1000 sq. ft. are practical, with lower weights at lower solids. Maximum weight is limited by the formation of objectionable pattern which, as mentioned earlier, will form above a certain coating weight with any coater where the final applicator or metering rolls rotate in the same direction as the web travel. The pattern formation depends on various factors, such as receptivity or absorbency of the web and coating viscosity and rheological characteristics, so it is difficult to give an exact figure of maximum coating weight. An approximate figure would be about $3^1/_2$ lb. per 1000 sq. ft.

The power required to drive the coating rolls is higher than with the Microjet because of the higher viscosity and the nip pressures involved, as well as the load imposed by the oscillating doctor. For a 100-in. coater at 400 f.p.m., approximately 20 hp. is required at maximum nip pressures. Of course, the centrifugal blower required with the Microjet does not enter into the Syncroset picture.

The Syncroset can easily be applied to the widest board machine. It is used on high-speed paper machines as a two side coater because of its high solids capacity. The relative inflexibility, which is a definite disadvantage for off-machine converting, can be considered an advantage for on-machine installations where coating weight must be accurately maintained and need not be varied greatly. Operation is simpler and more dependable than the Microjet. Maintenance is considerably greater as there is little wear in a Microjet. Due to the abrasive coatings used, Syncroset doctors have to be stoned or replaced every few days. Chrome plating protects the engraved roll, but the roll has to be replated about every 3 to 6 months. The coating weight will vary slightly and gradually as the plating wears down.

GENERAL CONSIDERATIONS

With either the Microjet or Syncroset, good board is required for best results. Serious defects will not be hidden completely by a light coating, although the appearance will be considerably improved. With either the Microjet or Syncroset, it is practical to use two coaters in tandem, with drying

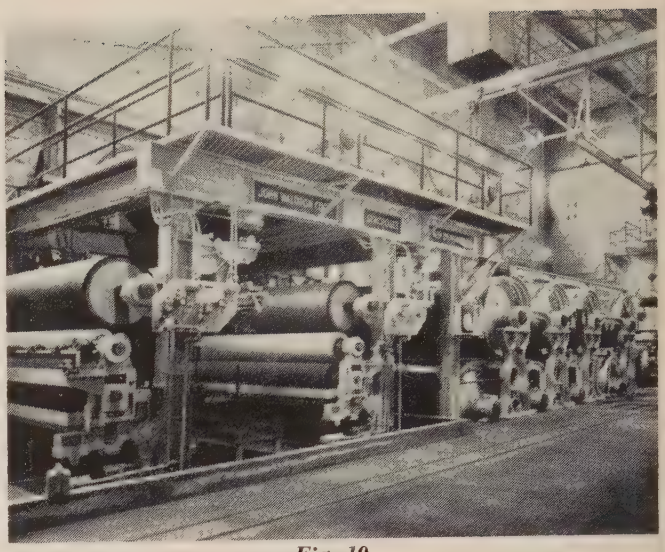


Fig. 10

between, to apply higher coating weights and cover a lower grade board. As mentioned earlier, coating weights above $3^1/_2$ lb. per 1000 sq. ft. are not practical with a single Syncroset coater due to the formation of pattern, but this weight could be doubled with two coaters in tandem. The Microjet has no practical upper limit as far as application is concerned, but drying requirements prohibit the application of too high a coating in one operation. Since much of the water in a light coating film is absorbed by the web, relatively little drying is required to remove the remaining moisture in the coating to the point where it will not pick off on subsequent rolls. However, with a high coating weight, water is absorbed primarily from the coating at the web surface, leaving the top of the coating at substantially the same solids at which it was applied, and requiring considerably more drying before the surface can contact a roll. Furthermore, a light coating can be dried more rapidly by the application of higher heat, without undesirable effects. For these reasons, it would be well to consider the use of two Microjets in tandem when high coating weights are desired.

The costs of the Microjet and the Syncroset are similar. Since there is considerable variation in cost depending on individual conditions such as speed, width of web, and type of coating, it is difficult to give an accurate picture of the price of a complete coating installation including the coating machine, drying facilities, and mixing equipment. It is worth mentioning, however, that the two types of coaters I have de-

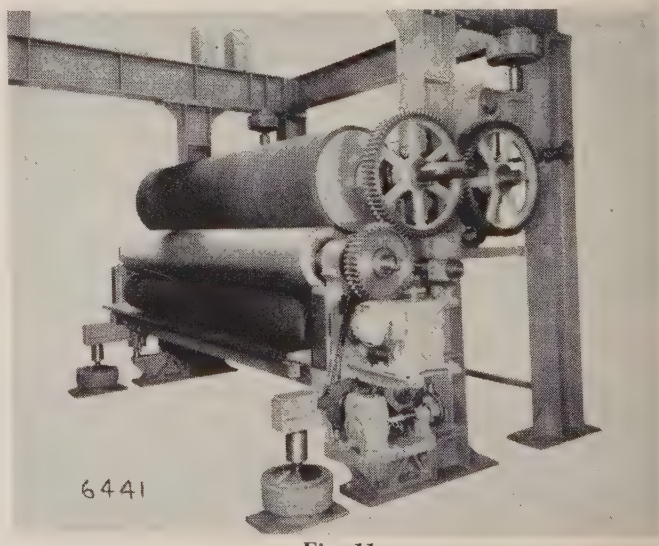


Fig. 11

scribed are sold on a royalty-free basis. Assuming that a 100-in. machine is producing 60,000 tons of board a year, and assuming a $1.00 a ton royalty for some methods of coating, $60,000 a year will be spent for royalties alone. At this rate, a Syncroset or Microjet coater can easily pay for itself in royalty savings in less than a year.

As mentioned earlier, the Microjet operating at 45% solids requires considerably more air drying than the Syncroset operating at 65% solids in order to prevent coating pick-off on the drying drums. In some cases, the Syncroset will require no air drying at all as much of the coating moisture will be absorbed by the board. The number of drying drums required by the Microjet is also greater than with the Syncroset. If we neglect effects of air drying and assume a 100-in. sheet operating at 400 f.p.m. with 4 lb. dry coating per 1000 sq. ft. applied in either case, the total moisture to be evaporated from the Microjet coating is 888 lb. per hr. This is on the basis of drying the coating to 5% moisture. The moisture which must be removed from the Syncroset coating is only 370 lb. per hr. Calculating the drying surface to remove this moisture, we find that four 42-in. drying drums are required with the Microjet while only two drying drums are required with the Syncroset assuming 50% effective contact surface. The actual drying drum requirements will probably be somewhat in excess of this figure allowing a safety factor.

While these drying requirements do not seem to be excessive, there is another factor that must be considered. If a water finish is used in the final calender stack, the coating must be made insoluble in order to prevent picking off at the calender. Apparently a certain length of time is required to complete the insolubilizing of the coating. This time has been found in practice to be in excess of the time required for drying. Consideration must be given to this factor when planning the location of the coaters with respect to the final calender.

SUMMARY

In summary, it would be well to compare the features of the two coaters. The Microjet operates on the controlled removal principle as contrasted to the metered application principle. The Syncroset can handle 65% solids coating, as against 45% solids with present clay-casein formulations. The Microjet has greater flexibility, but the Syncroset has the advantage of not permitting incorrect coating weights due to misadjustment. The Syncroset requires considerably less air drying to prevent the coating from picking off on the drying drums, although the Microjet can apply greater coating weights smoothly if drying is available. The Microjet applies from 3 lb. per 1000 sq. ft. up at 45% solids, with lighter weights possible at lower solids, while the Syncroset applies from 2 to 3 lb. per 1000 sq. ft. at 65% solids. The space requirements are similar, with the former Microjet design requiring more space and the latest design requiring less than the Syncroset. First costs of both machines are similar. The power required to drive the Syncroset rolls is greater than with the Microjet, but considerable power is required for the centrifugal blower. Maintenance is negligible with the Microjet, while replacement of doctors and replating of knurled rolls is a factor in the use of the Syncroset.

The Microjet and Syncroset are both suitable for board machine installations. Before selecting one or the other, the factors that have to be considered are first cost, operating cost including power, drying, and maintenance, available space, flexibility required, coating weight, and type of coating and board.

As all applications are usually somewhat different, the best decision as to coater type can usually be made after consultations with the various suppliers of coating materials, drying equipment, and coating machinery. Many of these companies maintain a staff of experts to provide technical assistance in setting up an effective coating operation.

Customer Requirements in Coated Boxboard

OSBORN M. CURTIS, JR.

I HAVE been asked, as the representative of one of the larger manufacturers of folding boxboard containers, to define to you the characteristics of boxboard which will meet our requirements—particularly in the coated variety of board. At the onset, let me say that we are, no doubt, most exacting in our demands, but we believe rightly so, as it is our constant objective to produce the highest possible quality of containers. Probably we are a "tough account" for a board manufacturer, but we appear to have some friends left, and I should like to express appreciation here to the board mills who have evidenced such wholehearted interest and cooperation in working along with us in the direction of constant improvements in qualities.

As I have said, our demands are exacting. However, it is a matter of considerable pride and satisfaction to us that we have recently been awarded, for the third year in succession, the First or Grand Prize in the annual contest conducted by the Folding Paper Box Association of America. In each case, the award has been based upon technical superiority of multicolor printing.

We cheerfully share these honors with the suppliers of the materials which we have employed in the production of these containers.

It is true that we have supplied the art work, and the designs, and the plates, and the press work—in short, the "know-how"—but all of these factors, important in themselves and the product of years of experience, could well have been nullified to a considerable degree had we not had, in each instance, level, uniform, and chemically correct board surfaces upon which to lay our impressions.

As printers and board manufacturers, our mutual objective is, of course, the production of folding cartons which will fulfill their functional requirements as packages of merchandise, and which will in addition (and this is of primary importance) be of such quality in terms of eye appeal that they will secure preferred display space, and sell readily from the dealers' shelves.

And, when we say "eye" appeal, what we are actually talking about in terms of boxboard, coated or otherwise, is the securing of surfaces and finishes which will permit of the highest types of color reproduction, be it gravure, letterpress, or offset lithography.

In placing orders for boxboard, we subscribe to the idea that the board mill is entitled to and, in fact, must have all of the information concerning the particular job. Our order forms carry this information: i.e., rotogravure, letterpress, or lithography—number of colors—gloss, metallic, or flat inks, and percentage of ink coverage—varnished or lacquered—percentage of unprinted areas—ink, varnish, or lacquer over scores—bending requirements—type of box, etc. With this information in hand, the board mill at least knows what it is "shooting for" and should be in a fair way to produce a proper board for the job in question.

I have not forgotten that my assigned subject is "Customer Requirements in Coated Boxboard," and my approach may seem to you to be circuitous. However, I think that some background of usage may help to establish the reasons for the requirements which I shall enumerate.

Let's follow a job through our plant, which, by the way, is completely air conditioned and maintained at constant levels of temperature and relative humidity—75°F. temperature and 48° R.H.

First, upon arrival the board is tested by "quality control" who check it for caliper, moisture content, ink absorbency,

OSBORN M. CURTIS, JR., Director of Purchases, The Lord Baltimore Press, Baltimore, Md.

hold-up of varnishes or lacquers, and bending ability. If the board passes muster, it is then printed by letterpress or offset lithography, whichever process has been planned for the particular job. Very many of the reproductions are from fine screen "halftones" and usually several colors are employed. The sheets of board may pass through a press several times. It is then varnished or lacquered. There is considerable heat in the application of lacquer.

Following this comes the die cutting and scoring, and the stripping operation.

At this point "inspection" takes over and those containers which are defective or below standard are discarded.

Then, these flat die-cut containers pass into high-speed gluing machines, which run from 30,000 per hr. up, are glued, counted, again inspected, and packed in fiber shipping containers. As you can see, and to put it bluntly, the board takes something of a beating and only those boards of the highest quality and degree of excellence can "come through" satisfactorily.

Each one of these operations impose severe and different stresses, not only upon the surface, but also upon the structure of the board, which, in each case, must be met by some particular inherent characteristic of the board itself.

In a general sense, what we require in coated boxboard is:

1. A uniform moisture content which will assure that the board will be in equilibrium with the pressroom atmosphere, to the end that sheets may be run from the skids without further necessity for conditioning by hanging; and which will run flat at high press speeds without curl or buckle and with a minimum of stretch, or shrink.
2. A proper rigidity and "snap" to the end that the finished containers may "form up" properly in the automatic filling machines which are in use by many of our customers.
3. Uniform level coated surfaces free from mottle or streaks which will accept fine-screened reproduction with "straight" or process inks; and of a chemical make-up to assure proper ink receptivity, and fast ink setting times, when printed at high speeds, either by gravure, letterpress, or offset lithography.
4. Surfaces which will support lacquers and/or varnishes without undue penetration over unprinted areas.
5. Coated surfaces which will not crack over the scores, particularly in the grain direction, particularly when the surface is printed, varnished, and/or lacquered over these scores.
6. A uniformity of sizing; and a sizing that will permit of fast absorption of the glues in our gluing machines, and in the high-speed packaging machines employed by our customers.
7. Uniformity of product in all categories; and, please let me emphasize this word "uniformity." It is very important.

We recognize that the board mills have many tests and controls to the end of producing better and more uniform grades of board, but, to date, the major part of our production difficulties stem from lack of uniformity in the board. Variation in surface and printing ability is a pressroom nightmare, particularly on high-speed presses. We can usually produce a fair job on a poor lot of board, if it is uniformly poor, but we have a very bad time indeed with deliveries of board which run 75% excellent and 25% off standard.

The inspection of thousands of printed containers to separate the good from the bad is costly in the extreme, and waste percentages eat rapidly into profits.

The variations from order to order, and from skid to skid, and often from sheet to sheet, particularly in moisture content, printing surfaces, and bending ability, are often very wide.

There is a saying in the trade "that the only true and final test of a board is to print it and see how you make out." We do not subscribe to this though in any degree, and believe that the board makers can set up tests and controls which will indicate and predict in advance what may be expected in performance, printing, bending ability, or whatever.

Further, we believe that the tabulation of the qualities established by the mill tests in each instance might well be passed along to the printer in advance so that he might know what to expect, and so be able to compensate for the known conditions before he goes to press—particularly in those instances where the variation from "standards" or specifications is a wide one. The printing press is a precision instrument and can't be fooled, but it is an unfortunate fact, in too many instances, that we do not have sufficient advance information so that we can predict, with any degree of certainty, the printing or bending qualities of a boxboard, short of actually printing and "finishing" the job.

Our "quality control" at best can only spot check a shipment of board. Our idea here is not to prove that the mill's test figures are right or wrong, but to determine whether or not we can run the board and what may be expected in terms of performance. We pass back our figures and performance records to the mill laboratories, so that they may keep a running record. We believe it is just as important for us to inform a mill of the outstanding qualities of a lot of board as it is to inform them of some deficiency in quality.

The merchandising and selling of packaged merchandise has grown rapidly and continues to grow by leaps and bounds. The container which, because of its attractive and colorful design, will win the best spot on the dealer's shelf is the one that sells best, and the printer who can consistently produce the bright, sparkling, well-printed container is the one who will win and hold the business.

Looking back over the past 25 years, I believe you will agree that the development of coated papers, as a whole, to its present status has been brought about by the necessity for producing surfaces which would meet the demands for sharper, cleaner, and brighter reproduction. There is no limit, in terms of quality of reproduction (except speed) so far as presses or plates are concerned. The limiting factor has always been a proper surface on which to lay the ink; and I think that the paper people have met the challenge in admirable fashion.

I submit that the same necessities now apply to coated boxboard. The demands are exacting, exactly parallel to those imposed upon coated papers, and the limiting factor in terms of fine color reproduction on coated boxboard is the quality and excellence of the coated surfaces.

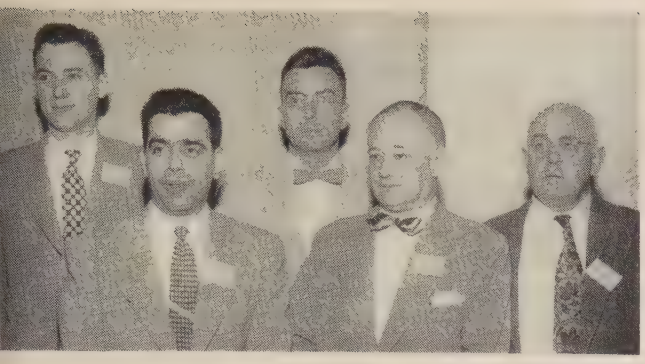
It goes without saying that we require and expect level coated surfaces which will not crack, or peel, or "pick," and that these surfaces must be chemically and physically formulated to meet the requirements of the various processions of reproduction. There is no one "best" process of reproduction—each one has its virtues and its faults, but each one demands a different type of coating. The coating for a flat ink litho job will not be the same as for a flat ink letterpress job, and so on. The increasing use of gloss inks, press varnishes, and lacquers requires coatings which will meet these conditions.

I am afraid that I have not told you very much that you have not already known. However, to sum up: the requirements in coated boxboard are for uniform level surfaces which will permit of high-speed multicolor reproduction. The demand, so far as the finished container is concerned, lies in the direction of bright colors and clear sparkling reproduction. As printers, we can supply the finest in plates and presses, and the best in skill, but, in the final analysis the excellence of the finished job will depend, in a large measure, upon the quality of the coated surface of the boxboard.

Coated Board Symposium

The panel discussion on the machine coating of paperboard convened Tuesday, May 26, 1953, at 3:10 p.m. Chairman Joseph T. Loomer of the Robert Gair Co. presided.

CHAIRMAN LOOMER: I will ask Messrs. Pomper, Fisher, Curtis, and Padavic to come up on the platform. I would like to say in advance that I am not only going to use the people up here as I see some of the board people in the audi-



A. W. Pomper, John Waldron Corp.; E. R. Padevic, Container Corp. of America; J. T. Loomer, Robert Gair Co.; O. M. Curtis, Lord-Baltimore Press, and H. C. Fisher, Gardner Board & Carton Co.

ence who can answer some of these questions too. If you have any questions for Mr. Curtis we will take them up in the next couple minutes, then get right in the question and answer part of the meeting. We will go through these questions and if there are any more from the floor, please don't hesitate to ask them. Some of the questions, or the answers to the questions, may instigate some more questions, so speak right up and we will try to do our best in answering them.

The first question is to Tony Pomper and it really is a two-part question: "Can the Microjet coater apply 65 to 75% solids coating colors without producing a pattern if the viscosity of the coating color does not exceed 150 cp.?"

A. W. Pomper (John Waldron Corp., New Brunswick, N. J.): Well, the answer to that first one is easy: yes, it can. We have applied 100% solids coatings with the Microjet without producing a coating pattern. Plastisols, modified plastisols, when I say 100%, have very high viscosity, but we did it experimentally. I wouldn't recommend it on a board machine. But you definitely can produce a smoother surface if you can get the viscosity down.

The second question: "If viscosity of the coating is low, do the rheological properties of it have an influence on the resulting coating with the Microjet coater?" Of course, the rheological characteristics of the coating are important. Thixotropic coatings, in general, will coat more easily under the high shear of the air jet. I doubt very much if you could use a dilatant coating with a Microjet coating. I don't know if that answers the second part of the question satisfactorily.

Chairman: We have a question here for Mr. Padavic. "Are smoothing rolls necessary in the drier stacks ahead of Champion coaters?"

E. R. Padavic (Container Corp. of America, Philadelphia, Pa.): We think they are necessary. We have them on both of our machines that have the coaters. They seem to give a more uniform coating with less high lights or blackening.

Chairman: We have a question addressed to Mr. Fisher: "Do you treat coated boards differently where they are to be printed with flat or gloss inks, and what test procedure is used?"

Harry C. Fisher (Gardner Board & Carton Co., Lockland, Ohio): Most often you can find a coating formula which will serve pretty well for both of them, but if it is an instance of wanting to have an extreme gloss or an extreme flatness, then you might want to make a separate coating. But we usually have something formulated which will serve pretty well with both, and let the ink formulator do a little work too.

As to the method of testing that property the Vanceometer is a pretty good instrument. We have just ordered one. But one of our men developed a type of test which is excellent but, it takes quite a while. We take a sheet of board on a proof press and put down first a flat ink, then on another area a semigloss, and finally a full gloss ink. Then on top of that print varnish over the whole so that you finish up with about 17 or 18 combinations on one sheet. In testing the board itself you may sometimes make use of what is known—for our purposes—as a varnish pressure test where we have a small printing plate, say 4 by 6 in., with a template 1 in. diameter in it. Take a double gloss varnish and squeegee the template on the plate, bring up the pressure to 100 p.s.i., for instance, then let the varnish sink down into the surface of the board. The time it takes will give you a pretty good indication of how the sheet will print.

But there doesn't seem to be very many tests that you can run real quickly to tell that; you have to sort of work backwards on the history of what you are doing and know the combinations to give you the result.

Chairman: We have a question here for Mr. Curtis: "In line with uniformity, what are your tolerances for: caliper, weight, smoothness, gloss ink qualities? And how do you measure smoothness and the gloss ink qualities?"

O. M. Curtis, Jr. (Lord Baltimore Press, Baltimore, Md.): They have asked for a definition of the measurement in line with uniformity of the tolerances for caliper. We subscribe to the so-called trade custom, the plus or minus one thousand on the caliper. The weights, I believe you board manufacturers are entirely within your rights when you say 5%, however, fortunately do not vary that much. Two per cent would be about as far as we care to go in either direction. Considering the smoothness, we are torn between many devices. Our quality control is currently engaged in a knockdown and dragout as to the proper device to use for a measurement of smoothness. I believe there is, technically, a difference between levelness and smoothness, one having to do with physical structure and the other with the reflection of light. I can't answer that question in its entirety because we are currently seeking better ways.

Our gloss ink measurement is not dependent upon the conventional pick test or wax test, or what-have-you. One of my jobs is to supply the ink department with a small square of the stock in question, and we mix up the ink, put a blank plate on, and slap it through the Vandercook. That is our measurement.

Chairman: One more for Mr. Pomper: "Does the Microjet coater require especially clean compressed air? And does the caliper of the board affect the choice of coater, all things being equal?"

Mr. Pomper: There aren't any particular precautions that have to be taken in keeping the air clean other than using a filter in the inlet to the compressor. We can't have large particles, such as scale from a pipe, get into the nozzle because they might jam in the opening and clog it. But that is something you don't expect in the air in any case.

We have installations where the blower is not located far enough away from the exhaust and some of the coated particles that are in the exhaust area get into the filter. It does no harm other than it means the filter has to be changed a little more often, or cleaned.

I don't think that the caliper of the board should affect the choice of the coater in any way. I can't see any really valid reason for deciding between one coater or the other on the basis of caliper.

Chairman: Now a question for Mr. Padavic: "How much coating weight can be applied in a two-stage coating process by the Champion method?"

Mr. Padavic: Roughly 3½ lb. per thousand square feet.

Chairman: About what per cent solids?

Mr. Padavic: That is, coated at roughly 50% solids, and we get about 65 or 70% of the coating on the first station.

Chairman: We have a question now for Mr. Fisher: "How do you stop alum from corroding calender rolls?"

Mr. Fisher: I was inclined to say, you don't, but we use chromium plated rolls and they last surprisingly long. I might say if the cost of making the coating water resistant

by some of these trick methods is calculated including that part of the calender rolls which go down the sewer, and is equated against the cost of doing it some other way, you would be suprised to find out the sewage isn't so expensive.

CHAIRMAN: The calender rolls are what, fifty-five cents a pound? Pretty cheap, anyway.

Now a question for Mr. Curtis: "What tests can you suggest to a paper mill to help them predict printability and your other requirements?"

MR. CURTIS: I don't think I can answer that. It is a little too broad. I think that is something that is a product of research and something that continues on through the years. I don't know the answer.

CHAIRMAN: I would like to say that is one of the tough things about the questions up here. Some of the questions as they are phrased would take a complete book and a complete annotated bibliography to answer them. Actually, questions would probably be a little more to the point if you sort of chopped them off and made them very blunt. You may get an answer and you may not. But in many cases we can give you a yes or no proposition.

This is for Mr. Pomper: "On the Microjet, what is the distance between the baffle and the backing roll, and the baffle and the tip of the nozzle?"

MR. POMPER: About the closest practical distance to run between the nozzle and the backing roll, or between the nozzle and the web, is about a quarter of an inch. Now, if you are operating at a 4–5° angle on the nozzle, the baffle would be about a quarter of an inch from the web. In other words, the front of the baffle would be roughly on a line with the front of the nozzle and approximately a quarter of an inch below the lower surface of the nozzle.

CHAIRMAN: We have a question here addressed to Mr. Padavic: "Would you wish to comment on the principal attributes of a board suitable for high gloss ink printing?"

MR. PADAVIC: Well, the coating required for high gloss ink printing must naturally be quite highly sized to hold the ink up. That is the only thing we depend upon. We size the body stock and the coating itself to a considerable degree at the same time, but not too much so that we prevent initial wetting required by high-speed gluing and filling machines.

I don't know if that sufficiently answers the question. If you have something particularly in mind, I will try to clarify that more.

QUESTION: By sizing I assume you mean additional grease resistance? Is that right? Solvent resistance? Not water resistance?

MR. PADAVIC: That is right. We vary the adhesive content somewhat.

CHAIRMAN: A question here for Mr. Fisher: "By insect repellency, do you mean an actual aversion of insects to the paper, or killing by contact?" I believe you mentioned something about adding an insect repellent on the calender.

MR. FISHER: It means an aversion of the insects to the paper rather than killing them but I would hesistate to speak as an expert on that. I merely mentioned that it is an old procedure that is used to make a board which has found some use in insect repellency, but I have never seen any evidence that the bugs fall over dead when they see it. They just don't like to get near it.

CHAIRMAN: I have a verbal question here for Mr. Curtis, and that is: "It has been said that as far as the smoothness of a board is concerned, it really doesn't matter too much as long as the board has this certain property called "cushion." I have heard some members say they didn't care how smooth it was, just as long as it had enough resiliency so they can get down to the bottom of the holes with their plates. Now is that a factor?

MR. CURTIS: Well, it depends upon the process of reproduction. If you are going to print, naturally a cushion is desirable, but your smoothness runs hand in hand with it because in letterpress reproduction the dot must be squarely with the level and smooth surface. If, in addition, you have a cushion which will permit the setting or the kissing of the impression without squeezing the ink up on the edges of the dot, that is desirable. A cushion is not particularly necessary in offset lithography because you are putting on a very thin film of ink which is following the convolutions of the pore.

CHAIRMAN: We have a couple more questions here for Mr. Pomper: "What is the recommended moisture content of the rawstock of the board just after the breaker stack or at the Microjet, before being coated?" And the second part of the question: "Do you recommend one or two calender stacks after the Microjet, or can you obtain sufficient calendering with one stack after the coater?"

MR. POMPER: Well, it is hard to give an exact figure for moisture content of raw stock. Actually, as I mentioned in my talk, it would be well to keep the moisture content down below 10%. If you get too high a moisture content there is that much additional drying, that much less moisture to be absorbed from the coating into the board. I don't think I can give too many specific examples here. I am not sure of the moisture content used on all of the coaters. However, the coater is invariably near the dry end of the machine. If you try it where you have about 30% moisture or so, I doubt if you would be able to dry the surface of the coating to the point where it wouldn't pick off on the drying drums.

On the recommendation of one or two calender stacks, I would prefer not to answer that in view of the fact that Mr. Fisher knows so much more about this aspect of it than I do. In general, a number of people seem to run only one calender stack after the coater, however.

CHAIRMAN: Harry, do you want to comment on the two-calender stack deal?

MR. FISHER: I would like to pass on that because I know nothing about his coating process.

CHAIRMAN: It seems we have a loose buck around here. It's been passed pretty rapidly. You might go on the theory that if you have two you will always find use for them. If you have one, you always wish you had two. So we can leave it in that stage and pass it on.

I have a question now for Mr. Padavic, although not specifically addressed to him. The question is: "Do you ever encounter fading with clay-coated board? If you do, is the coating or the base stock at fault?"

MR. PADAVIC: Unfortunately, it fades too much. There is a considerable amount of fading, actually, due mostly to the coating itself, not the white pigments but the tinting pigments. As far as the body stock goes, it fades to some extent, but is not too objectionable. At least, that is what we have felt.

CHAIRMAN: Harry, do you want to make a comment on that? Which fades the most, the base stock or the coating?

MR. FISHER: This is a rather ticklish point. One of the gentlemen I am acquainted with said one time one has to look at machine-coated board as an entirely new thing. It is not brush-coated board with heavy coating on it; it is not a board with a mere wash of coating on it, but it is something brand new as regards its generality.

Now the amount of coating on the average machine-coated board translated into terms of thickness comes down to a fraction of a thousandth of an inch thickness. I would hesitate to say how that compares with the various high quality paper coating, but it just suggests to one's mind that if the coating happens to be a bit translucent, you are going to get some fading due to the underlying stock. The extent that you can increase the fade resistance of the fiber surface under the coating will certainly increase the fade resistance of the coating itself. Of course, on the other hand, if you want to put a layer of putty on top of the sheet, then you possibly can get by with stock that doesn't fade so

much. So it takes a little adjustment to get the right results you want, but I do think, in fact I know, that the base stock has a good deal to do with the fading.

CHAIRMAN: I think this is a good question and I would like to rephrase it and say, do you ever encounter discoloration with clay-coated board in a sterilization process; which then discolors—the coating or the rawstock? Mr. Curtis, have you any experience with fading due to sterilization?

MR. CURTIS: No, I don't know anything about it.

CHAIRMAN: Any comments from the floor on that? Well then, we will pass that one.

QUESTION: Mr. Chairman, may I ask a question in return to that? Why is clay coating specified, and not other coating? Is your fading only in clay coating? If not, I would suggest why wouldn't it be base stock?

CHAIRMAN: I'm sorry I missed that. You are suggesting that clay coating does not fade and it probably is the base stock?

QUESTION: I believe the question as stated specified fading in clay coating.

CHAIRMAN: That is correct. In other words, the question originally asked which faded the most, the coating or the rawstock or was it a combination of both.

QUESTION: Why is the fading specified for clay coating and not for other coatings? Does the fading occur in the other coatings as well as clay coating, or only clay coating? If so, then I suggest that it would be the base stock.

CHAIRMAN: I think you are probably right on that. The question might have been a little wide. We do get fading on a lot of board that is not clay coated, and on those that are clay coated the fading we get, to some extent, probably can be attributed to the base stock. However, in some cases I think it depends on the coating. So you can flip a coin as to which fades the most. I would say it might be more the base stock than some of the coating, since the mineral part of the coating is fairly inert and has been bleached quite a bit already.

QUESTION: I am not going to try to answer the question, I am just going to ask a question. Isn't what we are talking about here really an alkaline discoloration? In other words, discoloration on the fiber sheet caused by the alkalinity in the coating itself under the influence of heat?

CHAIRMAN: Well, I'll turn that right back and say Harry has said that some of the coatings that are applied by means of calenders are acidic in nature and you can get discoloration from the acidic point of view as well as the alkaline. Any comments from the floor?

QUESTION: No, I think if you plot fade against the coating weight on boxboard you would see the degree of fade decreased substantially as your coating weight increased. Now, if it was your coating doing the fading, that would not be the result. It must be the body stock that is primarily the source of discoloration and fading. Of course, coating will fade also, but in proportion to discoloration to body stock, nowhere near as much.

MR. PADAVIC: I think you are right on that. It depends a great deal on what type of furnish you are using in the body stock. We use principally a 100% bleached furnish and the fading is very slight compared to the coating itself, the overcast of the coating on the plate glass, for instance. Of course, in this case we have fading of the pigment itself. The tint of the coating actually fades out to a normal cream shade, the normal clay coloring.

QUESTION: If you were to use dyes, the dye might bleed out, but that would be something else. I know if you take a sheet with a 100% pulp liner it will fade a good deal more than a sheet with the clay coating on it.

CHAIRMAN: To sum it up, normally with heavy coating weights, such as with brush coating, there is not too much fading. In the lighter coatings where the coating might be somewhat transparent, the fading might possibly be attributed to the base stock. If virgin stocks are used in the base sheet, you possibly will reduce your chance for base stock fading.

We can go on to another question, and we have another one addressed to Harry Fisher: "Do you recommend calender solutions (other than straight water) for application over the coating as well as under the coating?"

MR. FISHER: I believe I said in part of the paper, that if you wish to render your coating less porous, it is perfectly all right to apply something over the coating such as starch, or PVA, or anything you wish, as a film former, and let it fill up the pores of the coating. I might add that for many, many purposes that is not necessary, but it can be done.

CHAIRMAN: I have a question now for Mr. Curtis: "What fold or crease test is used on coated board, or is there a standard?" And second: "Does the fold or crease test agree with the bending properties of the board in actual use?"

MR. CURTIS: The question is: What fold or crease test is used on coated board? Is there a standard? It is an unfortunate commentary, I think, on our particular branch of the business that there doesn't seem to be any machine that will measure and tell us anywhere near accurately, or predict the bending ability of the board. What we actually do is to take the board and squeeze it on a jacket which is made up of the various widths of rules. If it bends, it bends; if it doesn't, it doesn't. I have heard that there is a device which does measure the bending ability of a board, that is after scoring, and indicates what can be expected in bending ability in terms of the depth of scores, but I have never seen such a machine in operation.

The second question was: Does the fold or crease test agree with the bending properties of the board in actual use? Short of the speed element, there is an agreement, because in substance what we are doing is taking the board and testing it with a particular rule and depth of rule. You do have a slight variance, of course, due to the fact that in your testing you are running very slowly, and in your actual operation you may be running very fast.

CHAIRMAN: I think it is the Howard Smith Crease Tester that was developed in Canada which some of the mills are using to attempt to forecast the creasability and possibly the bendability of board. I know we have one in our Canadian division, and as far as it is concerned, I think we regard it as a handy tool, but as yet I don't believe we have gone all out in saying that it definitely shows whether or not a board will crease well.

L. N. LYNE (E. B. Eddy Co., Hull, Que.): We have the Howard Smith creaser in our mill and use it as a quality control method and it seems to be working out very well. It is sort of a go and no-go gage. The board that will stand the Howard Smith will stand any fold, but conversely, I don't know it is true. I think some boards will hold actual use folds that will fail on the tester.

CHAIRMAN: Do you want to give a description how that test works?

MR. LYNE: It consists of a male and female grooved roller, with the female about two-thousandths or so greater in width than the male, which corresponds to the rule in the normal fold test. You manually run your sheet between these two male and female rolls, at slow speeds, and the crease is formed under constant pressure as it goes through.

CHAIRMAN: You can probably obtain a description from the CPPA. The creaser puts in a rolling crease which to some extent is a little bit different from the treatment that a board might get on a regular press. Of course it also makes no allowance, let's say, for the number of boxes that have to be run, which again is a factor. It is somewhat like the trouble the N.B.C. sound effects people had when they tried to duplicate the sound of a closing door. They spent a great deal of money doing it until somebody got the idea of just closing a door.

I do know that a good creasing operation makes a pretty tender board perfectly satisfactory.

I have another question here now for Mr. Pomper: "In your experience is it better to have a wet web or a dry web entering the Microjet coater?" And second: "What is the best moisture content for the web to give the least pattern, fast drying, and least picking at the stack?" And: "Is it the viscosity or other factors which set 45% solids as your top limit on the Microjet coater?" And fourth: "Would a low jet pressure, say 0.5 to 1.5 p.s.i., cause highs and lows and streaks in the coating on the web, assuming that the jet is not plugged or out of adjustment?"

MR. POMPER: Well, the first one, whether it is better to have a wet web or a dry web, I think I mentioned before that I believe it is much better to have a dry web, at least dry enough so that you don't require excessive air drying. It doesn't matter, let's say, in the converting operation where we have a hundred-foot tunnel to dry the web, just what condition of the web is going into the coater. However, on the board machine it is necessary to dry the surface of the coating in a relatively short time, and for that reason it is generally necessary to have a fairly dry web.

I don't think I can give an exact figure on the percentage of moisture, other than to say that probably it is better to be below 100%. Now, if we go to some sort of a coating that will not pick off, even though it is wet, we could run with any percentage moisture at which we could handle the web. The Erickson process is an example of this. The adhesive in the coating is precipitated after applying the coating, and once the adhesive is precipitated there is no danger of it picking off.

Now for the best moisture content for the web to give the least pattern, you should get a negligible pattern with any moisture content.

Is it viscosity or other factors which set 45% solids as your top limit on the Microjet coater? Very definitely the viscosity. As I stated before, if the coating people or the adhesive people can make an adhesive or a coating that can run up close to 100% solids and still have a low viscosity, the coater will apply it.

A low jet pressure, 0.5 to 1.5 p.s.i., will not cause high and low streaks in the coating on the web, assuming that the jet is not plugged. We have run some coatings with pressures as low as a quarter pound and have gotten good results. Now, if any of you are familiar with the brush coater you can see a difference between the coating surface as it leaves the Microjet and as it leaves the brush coater. The brushes actually work the surface of the coating and the appearance of the coating as it leaves the brushes is flat and glossy, actually a sort of watery effect, which would indicate that that surface is smoother than the surface of the Microjet-coated sheet which, while it looks smooth, does not have that gloss. However, the final result in the microjet-coated sheet will compare favorably with the brush-coated sheet.

CHAIRMAN: Question for Harry Fisher: "How does the rub and scuff resistance of inks printed on coated boards compare with the corresponding results on uncoated boards?"

MR. FISHER: Briefly, they can be made just about as scuff resistant.

CHAIRMAN: This apparently is a question for Mr. Pomper: "The amount of coating compound removed by the Microjet appears to be dependent on the viscosity of the coating. How sensitive is the Microjet to a viscosity change in coating mix and the variation in sizing in the sheet?"

MR. POMPER: I don't think I can give an exact numerical figure on the variation with viscosity. It is possible, with standard mixing and circulating equipment, to maintain very accurate coating weights by maintaining the viscosity constant. In other words, it is not a factor that is terribly important or terribly difficult to overcome. It is definitely within the realms of practicability to maintain a uniform coating weight with the Microjet. However, I should stress that it is something that requires considerable attention. If you mix a coating one day that is 200 cp., and the next day you mix it at 500 or 600, you are not going to hold exactly the same coating weight with the existing air pressure. On the other hand, if you do mix up a coating that varies in viscosity it is possible to adjust the coating weight by varying the air pressure. In a case like that you naturally would have to make weight checks from time to time.

Now, as to the variation in coating weight due to variations in sizing of the sheet, at a low speed, very low speed, lower than the speeds at which board machines generally run, I think you might get a considerable variation because there is time for the moisture to leave the lower layer of coating and penetrate into the sheet before the coating is hit by the air jet. On the other hand, when you increase the speed of the coater, the effect of variations in sizing of the sheet or absorbency of the sheet will decrease. At 400 f.p.m. there certainly would be much less variation due to variations in absorbency than at 50 f.p.m.

CHAIRMAN: I have a question here apparently for anyone who can answer it: "What is the normal range of water absorption for coated board (both top and bottom)?" And, "What test method is used?"

MR. FISHER: I don't know how to answer that question. You make a board for certain purposes, and that is getting down to some specific things difficult to discuss.

CHAIRMAN: I have a verbal question I would like to ask Mr. Curtis. I believe you said your shop was completely air conditioned and you normally run about 6% moisture in the board. Would you prefer to have the board shipped in so that you have to come down and meet your equilibrium or go up to meet it?

MR. CURTIS: It we can't have the board within the tolerances that we find are adaptable to our particular shop, we would prefer the high side, because I believe that we all recognize that paper and board will coast down and give up moisture rather gracefully without distortion. If it is on the dry side of equilibrium, it has a habit of bouncing out of shape rather rapidly.

QUESTION: Is there a method of measuring the coating weight on the board without knowing the base weight on the stock?

CHAIRMAN: Well, as far as we are concerned, we make a stab at it by two methods. We check the coating usage in the machine speed and get it in that manner. In the other way, we put in some slip sheets on top of the board and weigh the sheet before and after. Admittedly, there are some inaccuracies in that method.

MR. FISHER: The difficulty with the slip sheet method is it assumes that the surface of the slip sheet is the same thing as the surface of the board, which isn't true, and it also assumes that the pressure of the coating rolls on the slip sheet are the same, and that is not quite true because you have added a little thickness. But generally speaking, you know the performance of the machine and the results being produced; with the use of a slip sheet method you can certainly determine the variations, and check them back against the assumption. Of course, the other way is a long, drawn-out thing, and that is actually to analyze a coated sheet layer. Use, experience, judgment, and what-not have to play a part in there too, and I don't think there is any cut and dried method that is a hundred per cent accurate for doing that sort of thing.

CHAIRMAN: Tony Pomper has mentioned the fact that beta gages are being used before and after the coating. However, I think to be a little practical about it, the coating weight on the board at the present time is a small percentage and we can estimate it close enough without possibly going to the extent of installing beta gage. I do think at some future date there will be the need of a little more accurate con-

trol, but so far I don't think any one of us has felt the need for it.

QUESTION: I believe Mr. Curtis made the statement that he wanted his board to be chemically correct. Do you care to elaborate a little more on what you mean by that?

MR. CURTIS: Well, from a layman's angle, what I was shooting for was a coated surface or a surface that would be chemically correct for the proper receptivity of the ink. I can't elaborate beyond that because that takes me into fields in which I know nothing. We simply, when I say chemically, are balancing that as opposed to the physical properties of the surface such as cracking, bending, flaking, and picking. The absorbency and the ink drying times are roughly classed as a chemical property.

CHAIRMAN: If we have no more questions from the floor, I would like to express my personal appreciation to our speakers for having done a marvelous job, and to the audience for submitting so many questions.

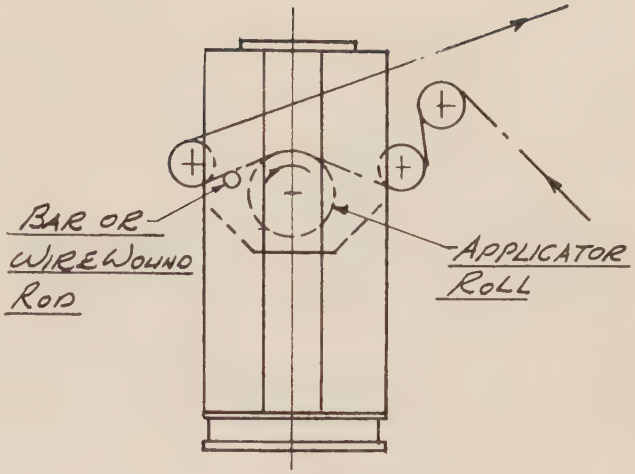


Fig. 2

Considerations in the Design of a Universal Coating Machine for Paper and Board

ROBERT J. JACOBS

CURRENT interest in coating machinery indicates a trend wherein extreme versatility is desired in order to handle a wide range of coating materials and webs.

While the converter would like to limit his use to one or two coatings most of the time and make long runs, the current sales picture is such that some competitive advantage must be brought forth in order to sell the product. This advantage may be price or delivery but our interest in coating machinery is confined to considerations of competitive advantages of quality and suitability.

Just as the furnish in making the paper must be changed to produce the best properties for specific applications, the coating materials and formulations must also be changed to produce the most suitable surface coating or treatment for specific applications.

Since there are hundreds of possible basic coating materials compounded into thousands of formulations which may be applied to a wide variety of paper, board, and other materials with different physical, chemical, and surface characteristics, the problem of how best to serve the customers' requirements becomes quite difficult.

Lately this problem has been further complicated by customer reluctance to order in large quantities on specialty items. This means short runs and expensive setups for the converter.

These trends have created a demand for coating machinery that will "do everything."

One other source demanding the "do everything" coating machine is the research laboratory or pilot plant whose responsibility usually includes new product development and application engineering on coated products.

In a progression of diagrams, utilizing one-frame construction, the steps necessary to produce this exceptional machine that will coat everything will be demonstrated. This machine will be further referred to as the Universal coating machine.

The initial setup will include one roll and a pan to show what can be done with that basic equipment. The machine will be expanded by adding extra rolls and auxiliary equipment such as doctors, gravure rolls, air knives, metering bars, and coating knives. All of these will conveniently fit into the one basic coating machine frame.

Some of the coating operations commonly performed with the different arrangements are mentioned.

The diagrams representing the coating machine are carefully threaded so that the coated side of the web always emerges uppermost as it goes into an oven or cooling section.

R. J. JACOBS, Manager Sales and Engineering, Dilts Machine Works Div., The Black-Clawson Co.

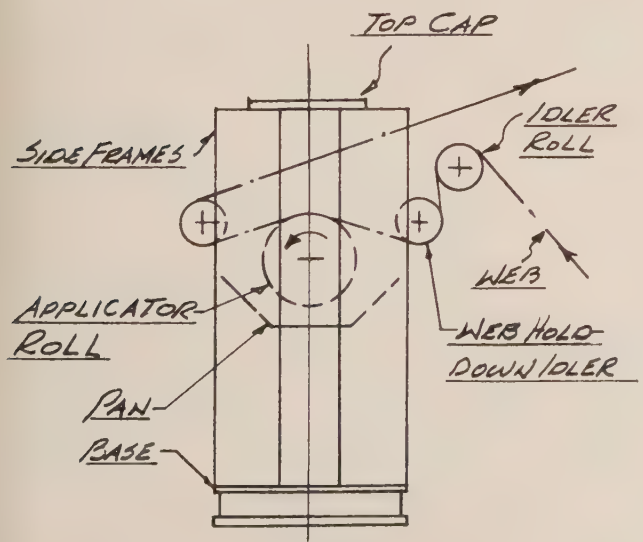


Fig. 1

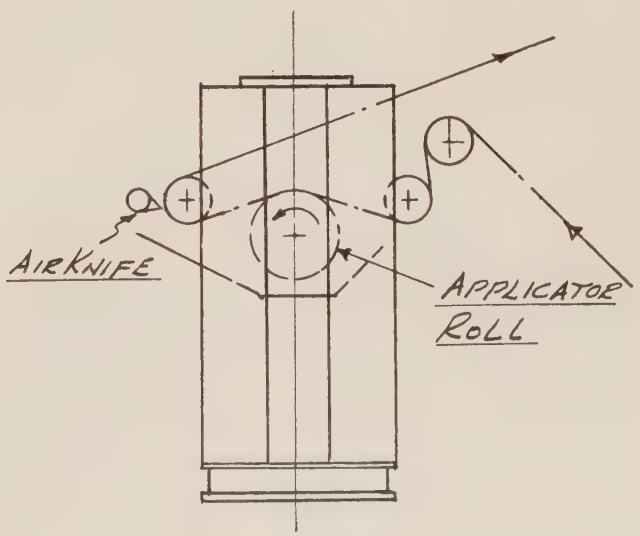


Fig. 3

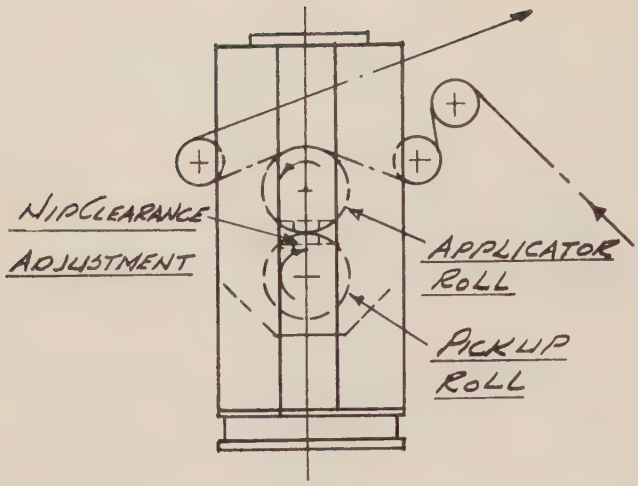


Fig. 4

It will be shown that the same auxiliaries can be used to good advantage in a wide variety of applications.

COATING MACHINE CONSTRUCTION

The basic machine consists of side frames that are finish machined on all surfaces. A common base mounts these side frames and holds them rigid. Coating rolls are added by inserting them on their bearings into slide ways between the frames. These rolls can be held in fixed position with a key, or be moved up and down by means of air cylinder actuation. One set of air cylinders may be mounted on the top cap which bolts on top of the side frames, and a second set of cylinders may be mounted in the base.

As the side frames are machined front, back, and on the inside surfaces, it is a simple matter to mount idler rolls as required to change threading. Doctors and other auxiliaries can be readily bracketed to the frames. Mounting holes are predrilled in the frames in all of the correct locations for these auxiliaries.

COATING POSSIBILITIES WITH ONE ROLL

One steel coating roll, keyed in position, is added to the basic framework together with a coating pan and three idler rolls. Threading is shown in Fig. 1.

Obviously, there is little control of what can be applied, but nevertheless, this simple method is sometimes found in use for applying adhesives, moisture, oil, wax, and asphalt, particularly in cases where the amount of coating applied is primarily dependent upon how much the web will take away.

In the case of hot melt coatings such as wax or asphalt, provision must be included in the pan, and preferably also in the coating roll, for heating to suitable temperatures. When

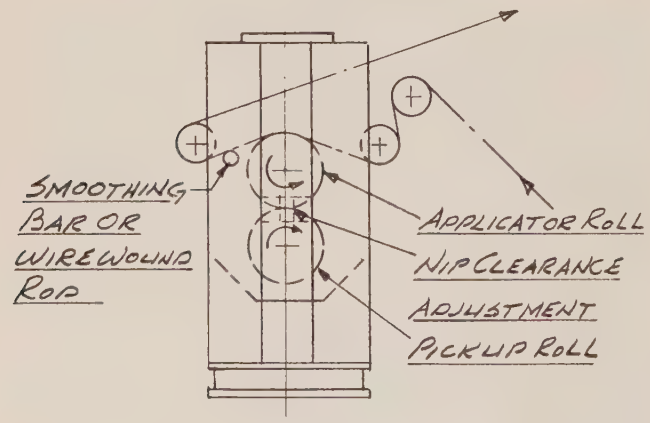


Fig. 5

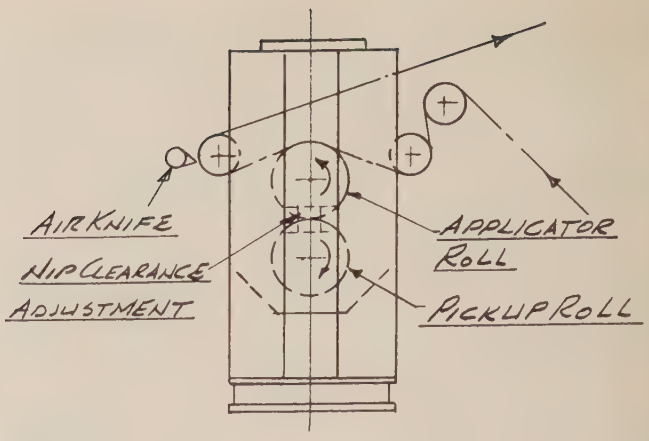


Fig. 6

some degree of control is desired on the coating weight applied, a bar or wire-wound rod can be added after the coating roll to remove a portion of the coating from the web as shown in Fig. 2.

This method is frequently used on carbon coating, waxing, gumming, sensitizing, and coloring at moderate speeds. As the speed goes up there is a pumping and throwing effect from the coating roll which causes difficulty, although in many cases it is satisfactory to run the coating roll slower than web speed to reduce this difficulty.

The bar or wire-wound rod tends to produce an even surface coating by filling the peaks and valleys of the web and removing the excess coating. They are usually rotated slowly so they will keep clean. In coating adhesives or asphalt, the bar may take the shape of a fixed blade whose purpose is to scrape off the excess coating. The maintenance of uniform tension in the web is a primary requirement for controlled coating weights in this method. Sometimes it is desired to apply an even amount of coating that conforms to the contour of the web surface, and this is done adequately on many coatings with an air knife in place of the bar or rod as shown in Fig. 3.

The air knife assembly would be supported on separate brackets that fasten to the side frames, and an extra wide pan to catch the doctored coating material is required. Common applications for the air knife are clay, diazo, and generally thin and fluid coatings with water as the solvent, or vehicle.

COATING POSSIBILITIES WITH TWO ROLLS

It is often desirable or necessary to meter the coating on the roll that applies the coating to the paper and this requires a second roll in the coating machine.

Figure 4 shows the Universal coater setup with two steel

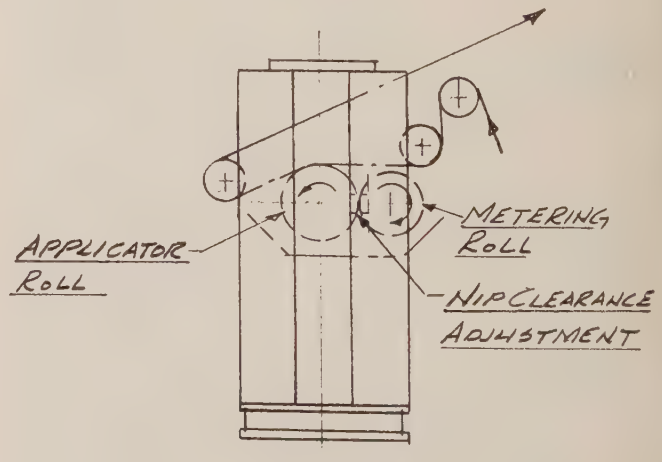


Fig. 7

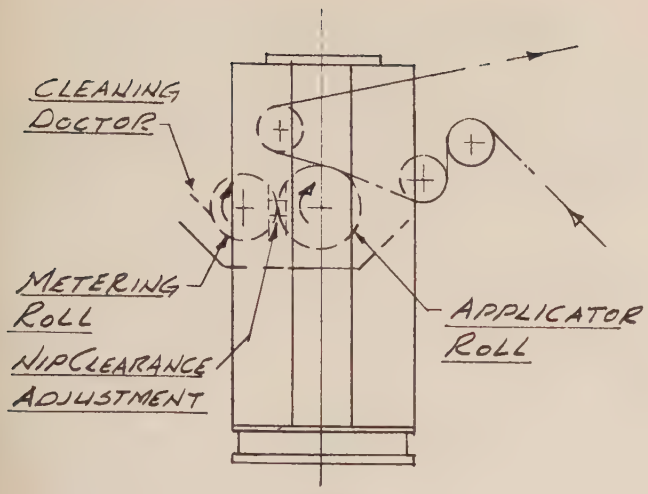


Fig. 8

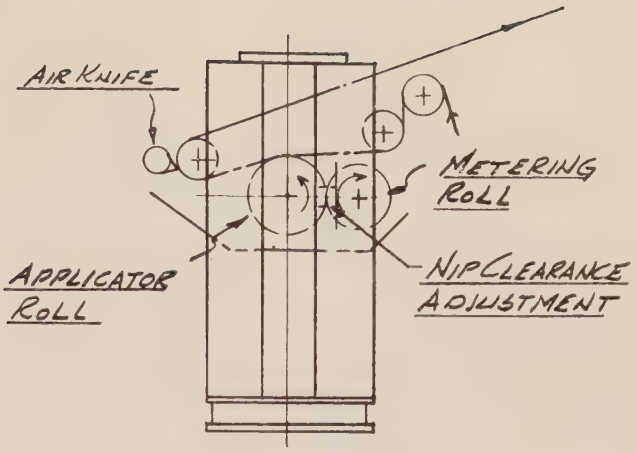


Fig. 10

rolls and three idler rolls. A means for accurately setting the clearance of the nips between the two steel rolls must be provided since this setting controls the metering.

The more accurately the rolls are ground and the more precise the nip adjustment, the better the control of coating weights applied.

The same sequence of coating applications can now be performed as with the single coating roll, shown on Figs. 5 and 6, except that in each case a greater degree of control will be obtained because the coating is metered before it is put on the web. The function of the bar or air knife with controlled metering is to smooth out the coating rather than to remove an excess. Higher speeds will be reached if pumping is the only limiting factor on the single coating roll.

Reverse wiping the coating onto the sheet is an alternate method of application, and it is only necessary to reverse the drive of the coating rolls.

The operations as shown here can also be performed with a metering roll in the horizontal position using the applicator roll to pick up the coating as well as to apply it to the web (see Fig. 7).

Separate slide brackets must be mounted to the side frames to support the metering roll. The main frames are recessed to allow the shaft of the horizontal metering roll to come through for a drive connection.

A long pan is required and note here that the applicator roll picks up the coating. The coating is metered off the applicator roll and applied by it to the web. The metering roll can be run in either direction with respect to the applicator roll. When run in reverse to the direction of the applicator roll at the nip, the metering roll is rotated slowly and a doctor is added to continually present a clean surface for metering. This is shown in Fig. 8. Since all coatings, even in the same family, do not necessarily act alike, it is difficult to predict which direction or at what speed to run the metering roll. It does appear, however, that fairly viscous coatings, such as starches and dextrines with high solids, operate more satisfactorily with reverse metering. The effect is a coating with less roping. Varying the speed of the applicator roll with respect to the web is another method of controlling the coating weight as it is applied to the web.

The important point is that variable speed and selected direction of rotation of the metering roll can readily be performed on the same machine, with direct or reverse application of the coating to the web as well.

The smoothing bar, or air knife attachments can also be added with the coating rolls in this arrangement and are shown in Figs. 9 and 10. In general, this method offers a slight advantage over the two rolls in the vertical plane previously shown because the coating is better confined, and subjected to less aeration and splashing.

It is difficult to doctor the applicator roll for a dry selvage edge on the paper in this arrangement, although thin steel fingers to lift the edge of the web are often placed over the applicator roll for this purpose.

The two-roll processes described utilize a kiss of the web

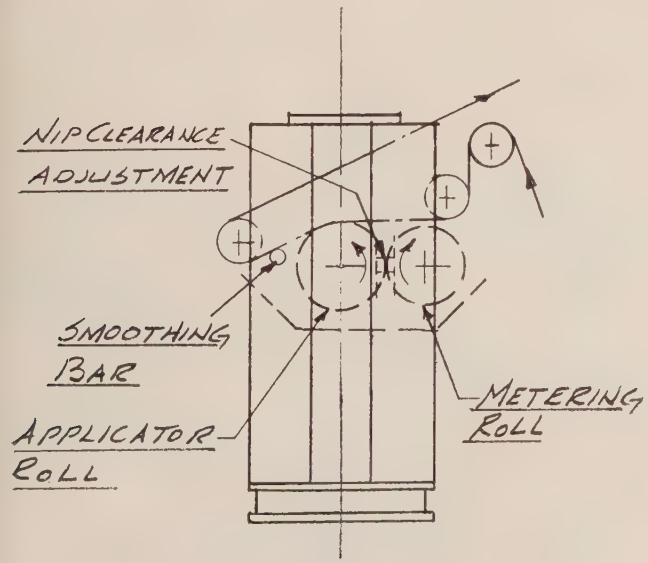


Fig. 9

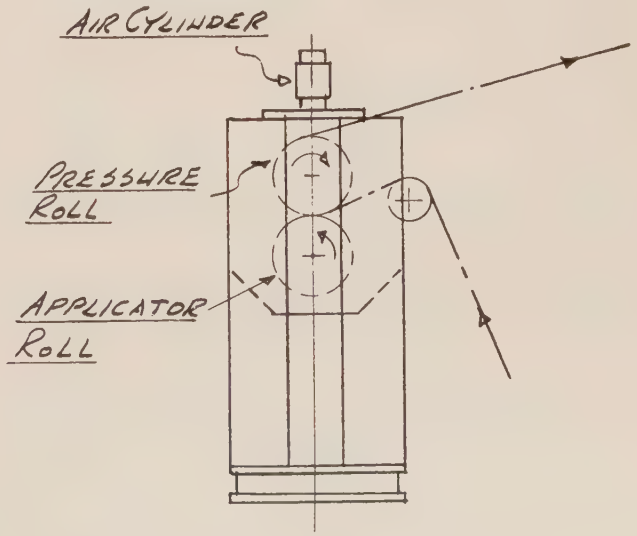


Fig. 11

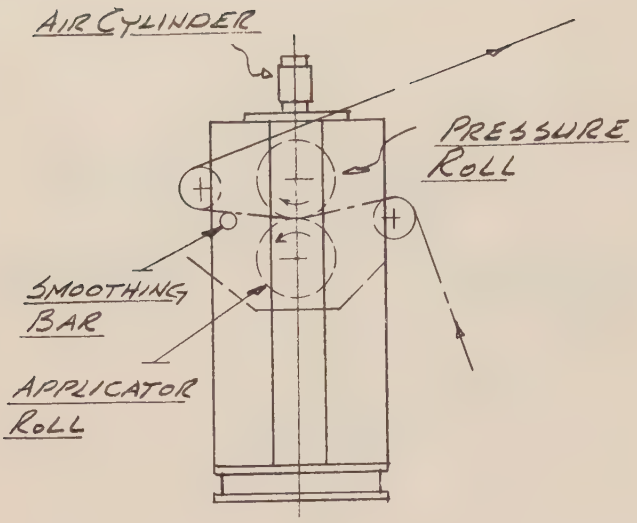


Fig. 12

over one of the rolls for applying the coating. In most cases, the rolls would be steel or chilled iron with an adjustable clearance set between them.

Here again, tension control of the web plays a very important part in the uniformity of the coating applied.

Another basic method of coating is to pass the web between two rolls. In most cases the pickup roll is steel and the top roll is rubber. Sometimes two steel or chilled iron rolls are used, particularly where heat or other factors would be detrimental to rubber-covered rolls. In this method, the stops that are used for controlling the nip setting are most generally removed or retracted and the coating control is obtained by the pressure or squeeze exerted on the web as it passes between the two rolls. Figure 11 shows this arrangement with air cylinder loading on the top roll.

This method is very common in waxing, asphalting, adhesive applicators, oiling, and impregnating.

The control of the amount of the coating is not only a function of the pressure between the rolls, but of the durometer of the rubber-covered roll as well when rubber rolls are used. Spare rubber-covered rolls of varying durometers are required for different coating applications to control coating weights. Proper crown on the rubber rolls is important for uniform coating by this method.

A smoothing bar can also be added to this arrangement as shown in Fig. 12.

By having a large deep tank and a dip roll assembly, saturating with asphalt, oil, wax, lattices, emulsions, waterproof solutions, and like can be done with the squeeze rolls removing the excess after saturation. Figure 13 shows this arrangement.

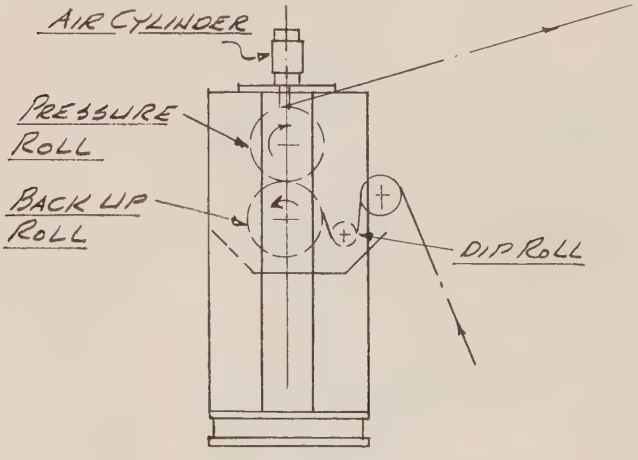


Fig. 13

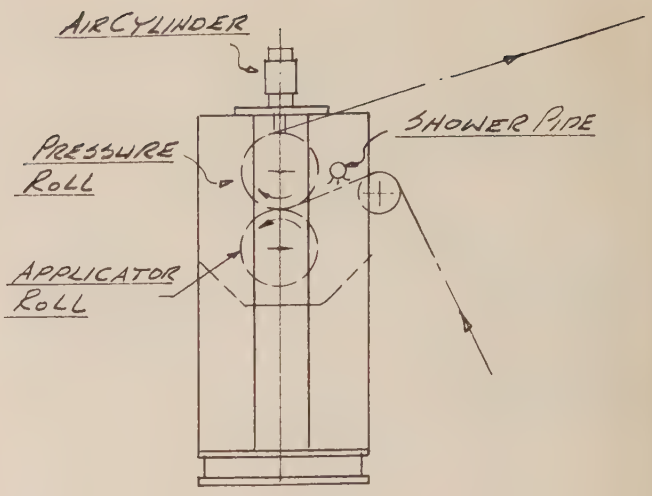


Fig. 14

Another method of saturation (or two-side coating) is to use a shower pipe on the top side of the web, and pick up the coating from the pan on the bottom side of the web. Pressure controls the amount of coating that is carried through by the web (see Fig. 14).

If an engraved roller and doctor are placed in the lower position and a rubber roll is mounted in the upper position, the machine can be used for gravure coating. The pressure available from the air cylinders must be sufficient for satisfactory transfer of the coating to the web in gravure coating (Fig. 15).

This process has an extremely wide range of applications for depositing controlled coating weights with an accurate distribution. The amount of coating applied is a function of the depth of cells engraved on the rolls and the per cent solids in the coating solution.

There is a limitation on how heavy a coat can be obtained by this method. It is normally employed on very lightweight coatings, and in cases where approximately the same amount of coating is to be applied most of the time. A stock of gravure rolls with different patterns is needed for various coating weights. Since a large stock of rolls can become quite an investment and involve a lot of down time for roll changes, gravure coating is not always too practical.

The process is used for applying lacquers, silicates, resins, emulsions, lattices, wax blends, aniline and pigmented inks, shown in Fig. 12. A smoothing bar is often used after the coating is applied to take out any pattern that might result because of the engraving on the rolls.

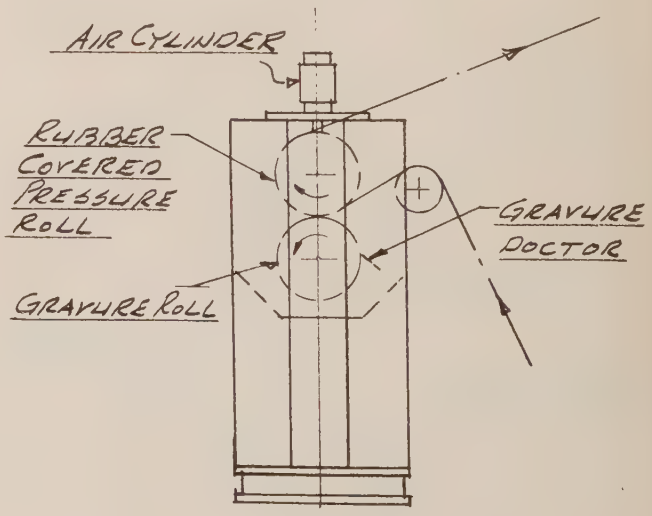


Fig. 15

COATING POSSIBILITIES WITH THREE ROLLS

Many of the same operations that are done with two rolls are also performed with three rolls. In the case of dry waxing, for example, lower coating weights can be obtained. The lower roll would be chilled iron, and the center and top rolls rubber covered. The center roll in the coater is fixed and the bottom and top rollers are aid loaded. Figure 16 shows this arrangement with the web passing between the two rubber rolls.

In other cases the bottom and center rolls are steel or chilled iron and utilize micrometer stops between them to give a clearance setting. The top roll is rubber covered and pressure loaded. This is quite similar to some of the methods discussed under kiss coating (Figs. 1 to 10). However, on kiss coating, floppy edges or lack of a uniform web frequently causes dry streaks. As mentioned previously, tension control is critical in kiss coating and if it is poor, the coating is not uniform. The rubber-covered pressure or backing roll corrects many difficulties of this type. On some papers, however, the backing roll cannot be used because the coating strikes through and backcoats the web. Hence, the kiss method is to be preferred in such cases.

Offset gravure coating with three rolls in the vertical position can also be performed on the coater. A gravure roll is placed in the bottom position with the doctor preferably mounted on the bearing housing so it will move up and down with the roll. The center roll is fixed and is rubber covered. The top roll is air loaded and either rubber covered or plain steel. Threading of the web is shown in Fig. 17.

On certain lacquers and emulsions, a pattern that may show up in direct gravure coating will flow out on the rubber transfer roll, and a more satisfactory and smoother coating can be obtained.

The two bottom rolls can be run reverse to the web and can apply more coating weight than the gravure roll alone could apply directly, if these rolls are oversped with respect to web speed. Figure 18 refers to this possibility.

All three roll coaters are not vertically arranged. By using a side slide bracket attachment, arrangements shown in Figs. 19 and 20 can be made in the coater.

The two rolls in the horizontal plane would be steel or chilled iron and stop adjustments between them control the metering of the coating. The top roll is rubber covered and air loaded. Again the same comments as made on the horizontal arrangement of two rolls confining the coating better, and of the pressure roll on the top of the web preventing dry

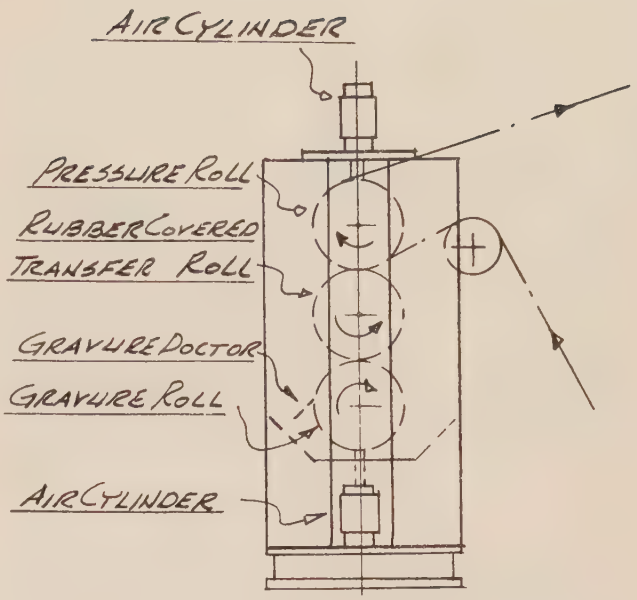


Fig. 17

streaks make this method desirable for starches, dextrines, latex and lacquers.

Figure 19 shows coating with the web and Fig. 20 reverse roll coating.

A variation of a three-roll setup can be employed for use as a kiss coater when using a heavy and viscous coat. The coating in this case is "worked" between two nips before it is applied as shown in Fig. 21.

COATING POSSIBILITIES WITH FOUR ROLLS

The coater can be developed fully into a four-roll coater. (Patent applied for—The Black-Clawson Co.—"Contracoater" trademark.)

This arrangement is depicted in Fig. 22, and is designed primarily for reverse roll coating. The bottom roll is steel, and is run in either direction depending on the coating material to be applied. The center roll is chilled iron, as is the metering roll, mounted in the side slide brackets. Accurate adjustments control the nip settings between these rolls. The top roll is rubber covered and air loaded to an adjustable stop position. The coating is picked up by the bottom roll, applied to the center applicator roll, and metered accurately by

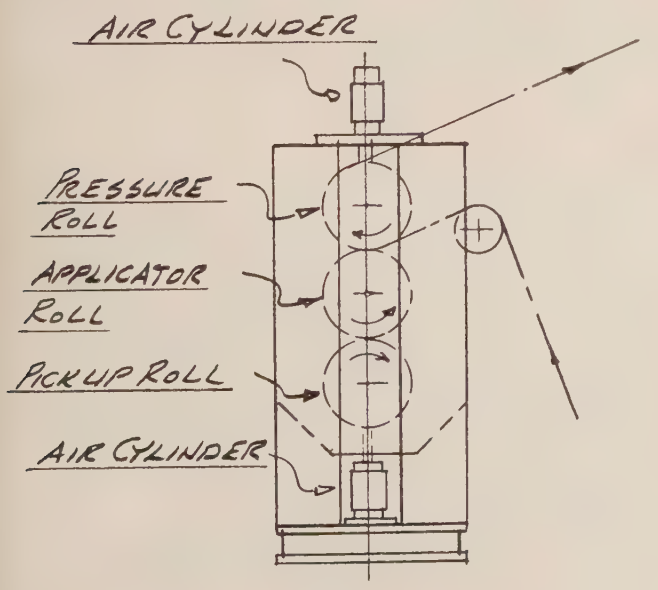


Fig. 16

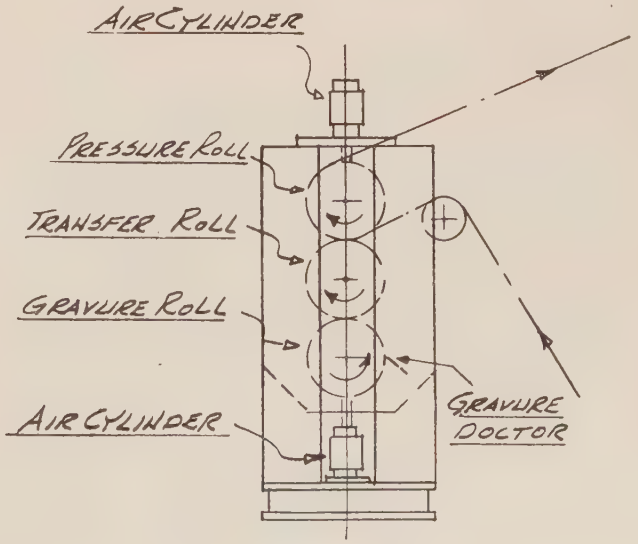


Fig. 18

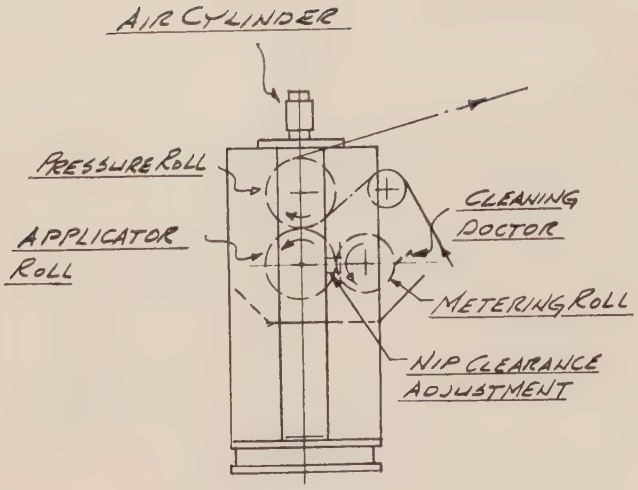


Fig. 19

the metering roll which runs in a reverse direction to the applicator roll. The applicator roll runs reverse to the web. By setting the nips, and by adjusting the speed of the three lower rolls to web speed or higher, a desired weight of coating may be applied. By having the nip openings set fairly close together, the coating will flow evenly on the applicator roll without ridging, and then by speeding up the rolls with respect to the web speed, very even heavy coats may be applied. Doctors on the pickup or applicator roll can control a dry edge.

This roll arrangement is especially suitable for viscous materials such as organisols and plastisols, although it is also suitable for applying a very wide range of coating materials such as wax blends, lattices, vinyl dispersions, lacquers, and various emulsions.

While it is not necessarily the least amount of coating machinery that can be used for certain jobs, it can be used to apply a greater range of coating material satisfactorily than any other single setup.

This covers the better known types of roll coating, except for very special designs, and all of these methods lend themselves to the one basic machine construction.

KNIFE COATING POSSIBILITIES

There is a point beyond which roll coaters do not operate satisfactorily in the extremely high viscosity range and on some stringy materials. Rubber cements and neoprenes would be examples of this.

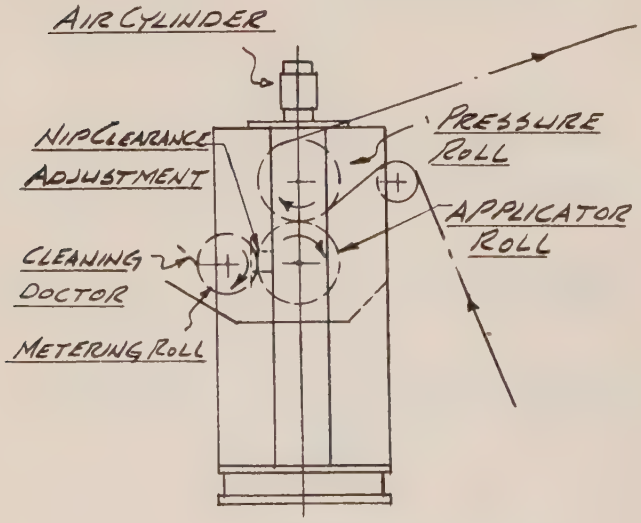


Fig. 20

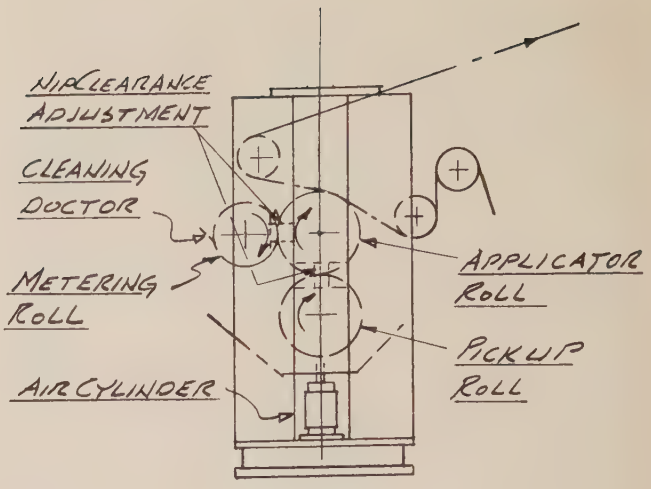


Fig. 21

Knife coating is generally accepted as the method for this work, with the coating applied by pump, can, or spatula in back of the knife. Most knife coating arrangements are quite simple and can be added to the Universal coater. The floating knife and knife over rubber roll are shown in Figs. 23 and 24 as they can be added with the knife attachment.

Knife coating of paper or board is also used on processes where low capital machinery investment is a consideration more important than good coating weight control. Most knife coaters suffer a high loss in waste due to streaks caused by particles becoming lodged behind the knife.

USE OF COMMON UNWIND, OVEN, COOLING SECTION, AND WINDER

It has been demonstrated how one coating machine can, by use of different rolls and attachments, operate in many different ways on many different coatings.

For the roll-to-roll coating applications, an unwind, oven, cooling section, windup, and drive are required to perform the operations discussed. The Universal coater could be used for sheet coating on board where the material has sufficient rigidity to prevent its sticking and wrapping to the coating rolls. However, it is designed primarily for roll-to-roll operation.

On solvent or emulsion coatings, the oven will most generally be used. The oven should be zoned and have a high-temperature fusing section at the end in case thermosetting resins are anticipated. The oven design and capacity are most important and may well be the limiting factors on the speed of the coating operation.

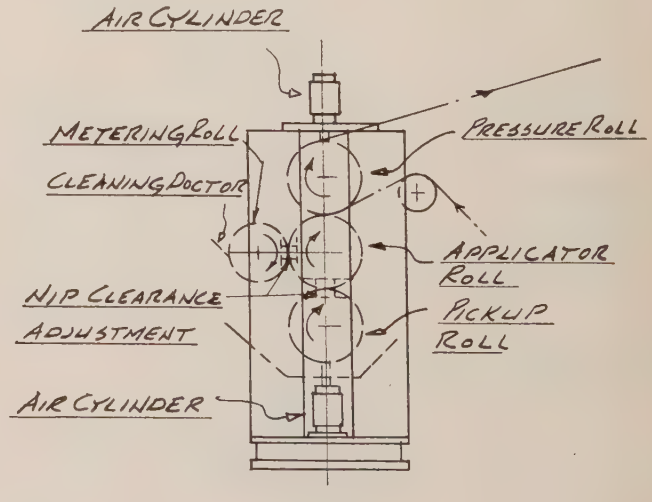


Fig. 22

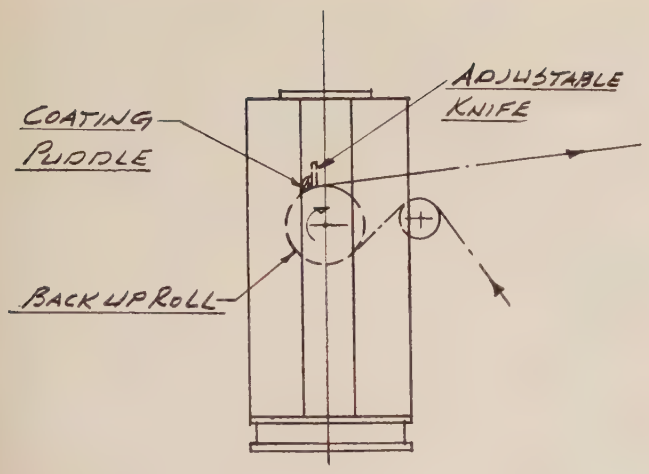


Fig. 23

The web will continue from the oven and be cooled over drums before being rewound.

On the hot melt coats such as waxes and asphalt, the oven is not used, and the web goes directly over the cooling drums from the coater.

Figure 25 shows a typical over-all coating line that would be used when the oven is needed.

If hot melts not requiring drying were used, the oven would not be needed, and the coating line would be much shorter as shown in Fig. 26.

For the truly Universal machine, the oven requires a high arch or return pass to keep the cooling section close to the coater. Then the coating line would be suitable for hot melts, by-passing the oven completely, as shown in Fig. 27.

POLYETHYLENE LAMINATING POSSIBILITIES

By adding a rubber-covered pressure roller against one of the cooling drums and installing an extruder, polyethylene coating on webs using the same unwind, wind, and drive can be performed on the same machine, as shown in Fig. 28.

This is really a novelty arrangement and while a possibility for a laboratory or pilot-plant work, it appears to have little or no desirability on a production basis, since polyethylene coating is efficient only on a continuous production basis.

ANALYSIS OF SUITABILITY TO LABORATORY AND PRODUCTION

The applicability of the Universal coater to laboratory or pilot-plant work is excellent. Here down time for setup changes, cleanup, rerigging are all expected. The primary

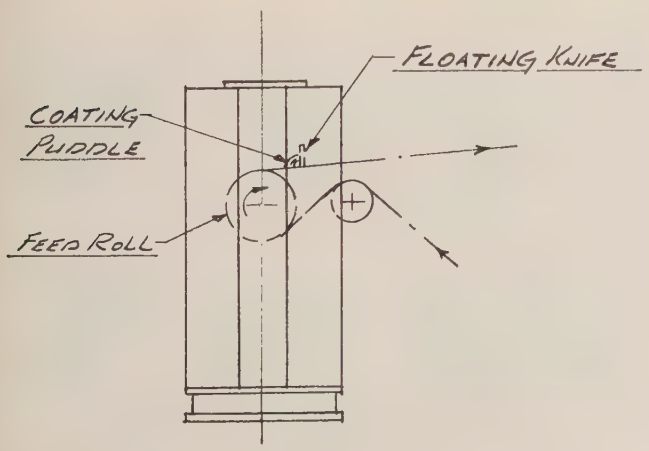


Fig. 24

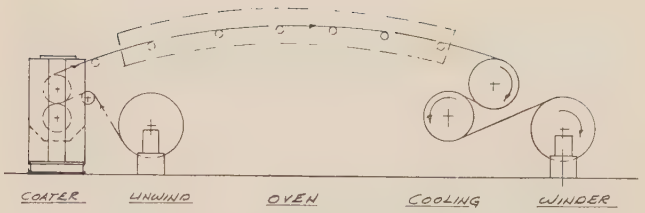


Fig. 25

objective is that the coating machine be capable of being set up to coat in every conceivable manner.

On the production line other objectives are more important and these include maximum operating speed, minimum down time, minimum waste, and minimum maintenance. These objectives often conflict with the requirement or desirability of versatility.

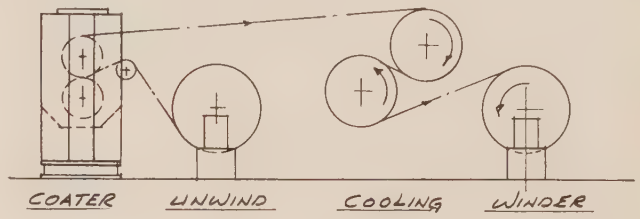


Fig. 26

In general, the most efficient production machine required to do a variety of work is one that is versatile within a carefully selected range of work.

A few of the factors that point to this conclusion on the limitation of a fully versatile coating machine from the design as well as the production standpoint are:

Solvent coats require drying ovens.
Hot melts do not require ovens, but require cooling.
Thin coats, or coats on bulky webs like board which can absorb water from some coatings, may require little or no auxiliary drying.

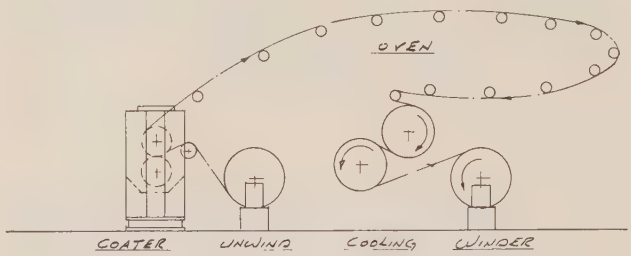


Fig. 27

Thick coats or coats on webs that are in themselves vapor barriers may require extremely long drying or slow drying. Some coatings require high-temperature curing.
Some coatings require gentle drying to prevent case hardening at the surface.
Board requires high tensions for proper handling.
Tissue and light papers cannot stand high tensions or they may sever too readily especially when wet.

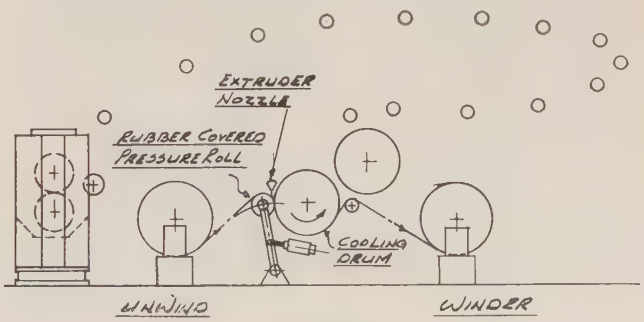


Fig. 28

Board may require large idler rolls to prevent checking, and stock may come in rolls over 72 in. in diameter.
Cellophane or foil may be handled in rolls down to 9 in. diameter and require short draws between idlers, usually spreader rolls.
Optimum coating speeds for different operations may vary widely.
Cleanups between various types of coatings, for example, from asphalt to clay, are impractical.
Bearings selected with large clearances for hot melts are too loose for accuracy on cold coatings.

For these reasons, Universal coating machines for production purposes are best worked out after an analysis of the operations to be performed. A listing should be made of the operations in the order of their importance and percentage of expected production. The coatings that are to be applied, the weights to be applied, and web materials to be coated should also be listed.

The process of selecting the Universal coater for production is very much like the process of analyzing each possible coating arrangement described in this paper. The combination of arrangements found necessary to do the operations listed that falls most logically within the pattern of the requirements can readily be selected by this method.

The machine finally selected is usually a compromise based primarily on the equipment necessary to perform the most important jobs, and secondarily, on the relative ease with which the operations of lesser importance can also be incorporated.

CONCLUSION

The conclusion is that pilot-plant coaters can be made Universal. Production coating machines are best made semi-Universal for a selected scope of work that falls within a carefully studied pattern, which would contain some, rather than all, of the variations described, and would be based on the physical and economical limitations for the various coating processes desired.

Pigmented Size Press Coatings Containing Dow Latex 512-K

L. H. SILVERNAIL and E. J. HEISER

It has been approximately 2 years since we made our initial size press run containing latex. During this period many runs have been made, and from these runs new data have been obtained. There are variables which have not been studied. Considerable additional work is needed in order to clarify the over-all picture. This report represents the progress that has been made to date and is not intended to be a finished report on size press coatings employing latex.

As indicated in the title, all of our work has been done on coatings containing Dow Latex 512-K. References made to latex throughout the text refer to this particular product. Comparisons are made between pigmented size press coatings and unpigmented starch sized paper. The data presented demonstrate the properties obtainable through the use of size press coatings containing latex when used as a precoat for subsequent conversion coatings, and when used as a new grade of paper for offset and letterpress printing.

PROPERTIES OF DOW LATEX 512-K

Dow Latex 512-K contains a copolymer of styrene and butadiene. The styrene to butadiene ratio in this copolymer is 60/40. The general physical properties of this latex are listed in Table I. It should be pointed out that Dow Latex 512-K is an anionic latex resulting in a negative charge on the polymer particles. As a result of the particular anionic stabilizing system, this latex has excellent mechanical stability but is susceptible to coagulation by acids and acid salts. Like other anionic latexes, Dow Latex 512-K can be coagulated by the addition of polyvalent cations. For these reasons, acid conditions and the presence of water-soluble polyvalent salts should be avoided wherever possible.

Table I. Physical Properties of Dow Latex 512-K

Solids, %	48.0 ± 0.5
Specific gravity (25°C.)	1.005
Weight solids per gallon, lb.	4.0
Antioxidant	None
pH of latex	10 ± 1
Viscosity	
Brookfield, cp.	10–12
Ford cup No. 4, sec.	10–12
Particle size, mu	0.2
Surface tension, dynes/cm. at 25°C.	28–32
Devolatilized	Yes
Tensile strength, lb./sq. in.	300–800
Elongation, %	700–1000
Charge of particles	Anionic (negative)

PROPERTIES OF COATED PAPER CONTAINING LATEX

Several years of using latex as a partial adhesive in machine and off-machine coatings has demonstrated its utility as an adhesive. Unlike other pigment binders used in paper coatings, the polymer in latex is somewhat thermoplastic. As a result, it flows and permits the movement of pigment particles when subjected to heat and pressure during calendering. This property increases the effectiveness of calendering, giving a product of superior smoothness and also improves gloss development. Latex has excellent pigment-binding properties and imparts wet-rub resistance which is so important for offset printing (*1*). As a result of the polymer being a water-insoluble material, dimensional stability and freedom from curl are enhanced. This same property permits the manufacture of a coated paper which is less affected by changes in atmospheric humidity than coated paper containing water-sensitive adhesives (*2*).

Latex is being used in the paper industry in conjunction with casein, isolated soya protein, starch, and glue to produce many types of coated paper. It is seldom used as the sole adhesive, and normally represents 25 to 50% of the total adhesive content. Typical examples of coated paper products employing latex are (1) folding, high gloss enamels for letterpress printing; (2) flat, nonpicking, moisture-resistant paper for offset printing; and (3) high-grade, washable wallpaper.

SIZE PRESS COATING FORMULATIONS

The intended end use of the coated paper determines the composition of the formulation. For example, when improved strength properties, maximum water resistance, and varnish holdout are the main factors, a high binder to pigment ratio is desirable (*3*). For a given pigment system, when opacity and brightness are the determining factors, the binder to pigment ratio is reduced (*4*).

As a compromise between the two extremes in binder level, we have conducted many size press runs using a formulation consisting of 100 parts of pigment, 17.5 parts of latex, and 17.5 parts of starch. This original formulation is normally modified to produce the desired properties for the individual papermaker.

PREPARATION OF SIZE PRESS COATING COLOR

The components and proportions of a typical size press

L. H. Silvernail and E. J. Heiser, Coatings Technical Service, The Dow Chemical Co., Midland, Mich.

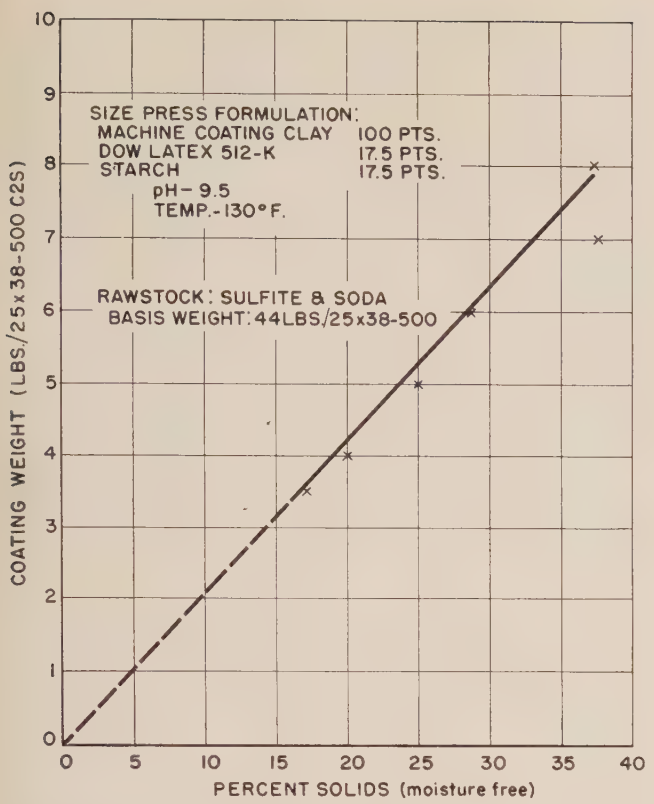


Fig. 1. Coating weight versus coating color solids

Table II. Typical Size Press Formulation

Per cent solids of coating color—40%

Dry weight, lb.	*Wet weight, lb.*	*Ingredients*	*Used as*
100.0	154.0	Machine coating clay	65% aqueous dispersion
17.5	46.0	Stabilized Dow latex 512-K	38% dispersion
17.5	87.5	Starch, enzyme converted	20% aqueous solution
	50.0	Water	.....
135.0	337.5		

coating are shown in Table II. Although machine coating clay is listed, other pigments have been used. For example, a 50% replacement with titanium dioxide increased the brightness 4 points over that obtained with 100% clay.

Similarly, other starches besides enzyme converted have been used. Successful runs have been made with oxidized and etherified starches. It should be pointed out that the lower viscosity grades are normally preferred in order to obtain practical coating color viscosities at desirable solid contents.

Viscosity and density data are shown in Table III. The starch in this particular case was an oxidized starch. The viscosity figures, as measured by the Brookfield Syncrolectric viscosimeter, show that the color possesses some degree of thixotropy. These data also indicate that, when the temperature of the coating color is raised 70°F., its viscosity is reduced to about one-third that at room temperature.

Table III. Viscosity and Density of a Size Press Coating Color

Ingredients		*Parts solids by weight*
Machine coating clay		100
Starch, oxidized		17.5
Dow latex 512-K		17.5
	pH	9.5
	Total solids	40%
	Density: 10.13 lbs./gal.	

Brookfield Viscosity

R.p.m.	*Spindle*	*Reading*	*Viscosity cp.*
	Temperature 150°F.		
6	2	161	1610
12	2	189	945
30	2	46.9	469
60	2	231	231
	Temperature 80°F.		
6	2	255	2550
12	2	318	1590
30	2	87.5	875
60	3	31.8	636

There is normally some question as to whether existing equipment will handle coating colors of this composition. Satisfactory operations have been obtained with a variety of pumps. For example, at one trial run, which provided some of the data for this report, a coating color containing 40% solids was pumped with a $1^1/_2$-in. centrifugal pump having a rated capacity of 30 g.p.m. against a 15-ft. head when operating at 1270 to 1450 r.p.m.

In addition to pumps, there is always the question of the suitability of existing mixing equipment. In the trial runs to date, a variety of mixing equipment has been used. This equipment has ranged from 55-gal. drums equipped with portable mixers to large tanks with paddle-type agitators. Actually, the most important point to consider is the degree of agitation obtainable. This agitation should be sufficient

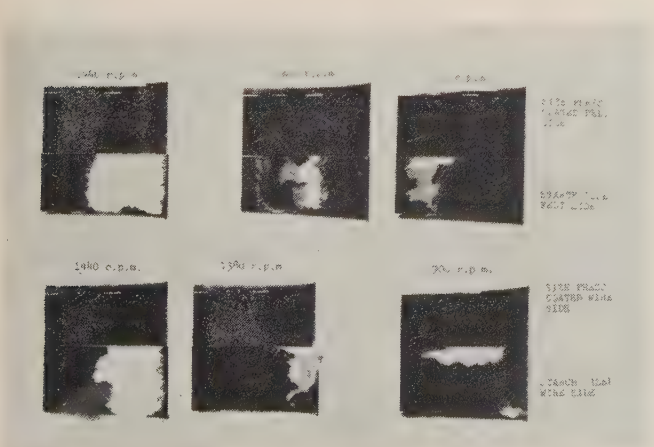


Fig. 2. Body stock picking resistance of raw stocks

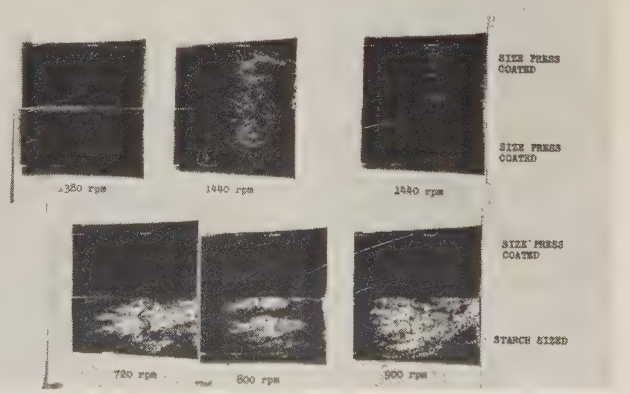


Fig. 3. Body stock picking resistance of conversion coated papers

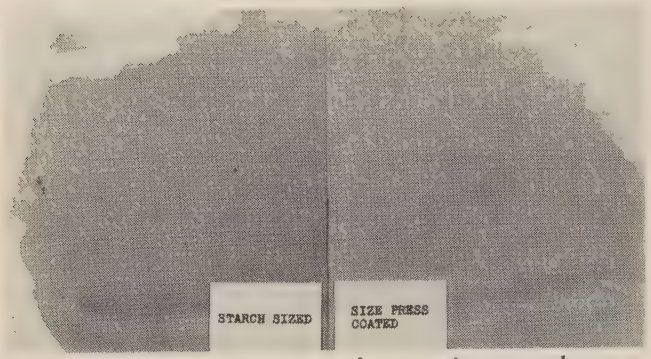


Fig. 4. K & N ink receptivity of conversion coated papers

to thoroughly disperse the pigment and to blend in the other ingredients. Since the viscosity of a typical pigmented size press color is higher than that of a straight 10% starch dispersion, an agitator which is just capable of stirring a starch dispersion of this concentration may not be large enough for the preparation of a pigmented color.

The methods of color preparation are normally varied to fit particular mill conditions. The usual method of preparation has been the one suggested in the Dow Co.'s size press bulletin. In this case, the dry pigment is added to water containing a complex phosphate dispersant. The cooked starch dispersion is then added followed by the addition of protein stabilized latex.

A second method of preparation has been employed. This method involves the cooking of the starch in the presence of the pigment. When this method is used, it is necessary to cool the over-all mixture to a temperature of 150°F. before the stabilized latex is added. This method requires more time as a result of the cooling period and also slightly increases the steam consumption.

A third method, which has been employed quite successfully, involves the initial making of the starch dispersion to which a dispersing agent and more water are added and the dry pigment is dispersed in the starch dispersion. The advantages of this method are that no additional equipment is required. The preparation of the entire coating color can be carried out in a starch cooker.

The stabilized latex should always be the last ingredient added independent of the method of preparation. The reason for this is to minimize the formation of foam and to reduce the mechanical shearing action to which the latex is subjected.

Latex is not as compatible with starch dispersions as it is with proteins. For this reason, it is always advisable to stabilize the latex with a protective colloid, such as isolated soya protein or casein. The usual requirement for stabilization is 3% protein solids based on the latex solids. The protein is normally added as a 15% alkali cut dispersion. In our experience, size press coating colors containing latex stabilized in this manner have been run on the size press continuously for more than 5 hr. without difficulty.

It is normally necessary to employ antifoaming agents. Typical antifoamers, such as the higher alcohols, pine oil, and many commercial defoamer preparations, have been used in this system. The weight of defoamer used necessarily varies with specific mill conditions. In order to obtain the maximum efficiency from some antifoamers, it is suggested that a small portion be added initially to the color followed by dropwise additions at trouble points.

APPLICATION OF SIZE PRESS COATING COLORS

Size press coating colors have been successfully applied with many types of size press roll combinations. Rubber, chrome, and brass combinations have been employed with no apparent difference in the appearance of the resulting coating. Picking of the coating on the size press rolls or drier rolls has not been a problem with properly formulated colors. The drying of coatings of this type on conventional paper machines has not presented any difficulties. The reason for this can be shown quite simply by weight calculations. In normal starch sizing, if a 2-lb. starch pickup is assumed from a 10% starch dispersion, the total weight pickup is 20 lb. of which 18 lb. are water. Then, assuming an 8-lb. pickup of a pigmented coating from a 40% solids color, the total pickup is 20 lb. of which 12 lb. are water. This indicates that approximately 6 lb. less water needs to be evaporated from the pigment coating than from the starch sized sheet. These figures are taken on the basis of a 25 × 38—500 ream.

We have never determined accurately the effect of machine speed, furnish, or internal sizing. We have been present on trial runs in which machine speeds varied from 250 to 750 f.p.m. To date, we have not been able to determine the effect of paper pH and acidity on coating performance. However, it is felt that a coating color containing latex should be held close to a pH of 9 to 10 in order to obtain maximum stability. Therefore, it is probably inadvisable to use a low pH paper without taking necessary precautionary measures to hold the pH high.

Coating weight pickup on a given furnish is readily controlled by variations in the per cent solids of the coating color. A curve of coating weights versus coating color solids is shown in Fig. 1. Examination of this curve demonstrates that the coating weight pickup is directly proportional to the per cent solids of the coating color.

SIZE PRESS COATING AS A CONVERSION COATING BASE

The use of pigmented size press coatings containing latex have definite advantages as a precoat for subsequent conversion coating. There is an increase in strength properties as compared to normal starch sizing. For example, with a 6-lb. size press coating containing 100 parts of clay, 20 parts of latex, and 20 parts starch on 44-lb. stock, the bursting strength was increased by 17%, tearing strength by 27% in the machine and 19% in the cross-machine direction, and the resistance to air penetration (TAPPI Standard T 460 m-49) increased by 500%. Sizing dropped off somewhat and the wax pick dropped 1 point on each side. The reduction in sizing was probably due to the presence of pigment and the alkalinity of the coating. A drop in wax pick is considered normal whenever latex is used as part of the adhesive. This drop is not due to a weaker coating but to the thermoplastic nature of the latex. Pick tests run by another method show that coatings containing latex are as strong or stronger than those without it. Latex size press coatings also increase the body stock picking resistance. This can be illustrated by comparison of body stock picking resistance of size press coated stock

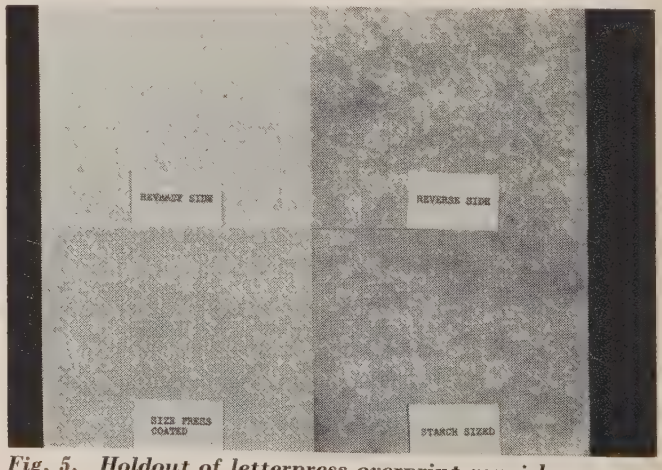


Fig. 5. Holdout of letterpress overprint varnish, perpendicular view showing penetration

and normally starch sized paper using the S. D. Warren Machine Print Tester. Machine print tests (Warren tester) were made on samples and the results are shown in Fig. 2. These tests indicate that the starch sized stock ruptured quite readily where the size press coated paper was virtually unaffected. These tests were made with a very tacky offset ink after the samples had been conditioned 24 hr. at 50% R.H. and 75°F. The raw stock furnish was identical in both cases.

The foregoing data look very impressive, but it may be questionable whether the improvement in strength properties is due to the increase in basis weight or the result of the coating. Probably, it is a result of both factors. To further clarify this picture, these papers are followed through subsequent off-machine coating operations.

The starch sized sheet was overcoated with 26 lb. of coating containing pigment, casein, and latex. The size press coated sheet was overcoated with 20 lb. of coating in which the casein portion of the binder was reduced by 10.0%. This procedure resulted in a final basis weight of 70 lb. for both samples. The results of the physical tests reflect the influence of size press coating. These results are shown in Table IV.

Table IV. Physical Properties of Conversion Coated Paper—Run No. 1

Raw stock	*Size press coated*		*Regular starch sized*	
Basis weight, lb....	50 (25 × 38—500)		44 (25 × 38—500)	
Top coat, lb.....	20 C2S[a]		26 C2S	
Basis weight (coated), lb.....	71.1	70.0	71.1	72.2
Caliper, in.....	0.0035	0.0035	0.0035	0.0035
Burst, p.s.i.....	28	29	23	24
Tear, MD/CD, g...	50/52	50/54	40/48	44/52
Tensile, MD/CD, lb./1/2 in.....	12/6.5	12.5/6.5	11/4.5	12/6
Bekk smoothness, F/W.....	660/650	730/630	780/560	790/580
Brightness, F/W...	76/77	76/77	77/77	77/77
Dennison wax, F/W	7/7	7/7	5/5	5/6
K. & N. ink, F/W..	61/65	63/66	58/60	53/55
Gloss, % F/W.....	48/51	48/53	52/53	49/52
M. I. T. fold, MD/CD.....	80/42	72/45	37/14	30/14

[a] Casein portion of binder reduced 10%.

The Midwest mill carrying out these trials reports as follows: "We cut the casein portion of the top coat binder by 10.0% and obtained 1 to 2 points higher wax pick. The 'pop' was increased 4 to 5 points. The tensile strength was increased 1 point. There was a big difference in fold (in favor of the latex size press coated sheet). The coated paper using size press coated stock gave a fold of 77 in the machine direction and 42 in the cross direction. Our standard grade using starch sized stock was 35 in the machine direction and 14 in the cross direction. The size press coated paper was a little harder to ink penetration. The brightness and gloss were down 1 point on one side and the microscopic surface was not as solid." This particular mill concluded that they could further cut the casein portion in the binder by an additional 5 to 10% and improve the ink receptivity properties of the coating. Another trial run made by the same mill but on a heavier basis weight stock gave results which closely paralleled those of the initial run. These results are shown in Table V.

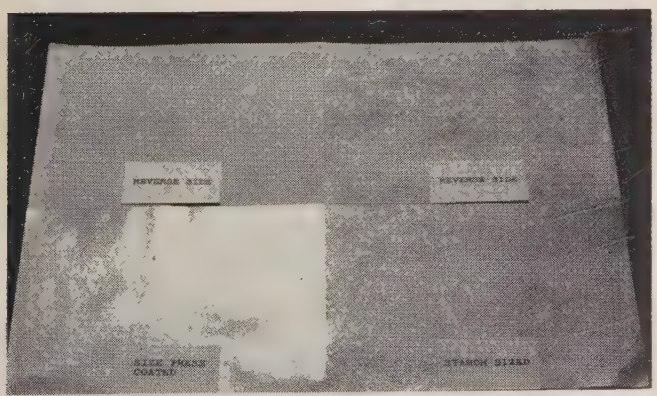
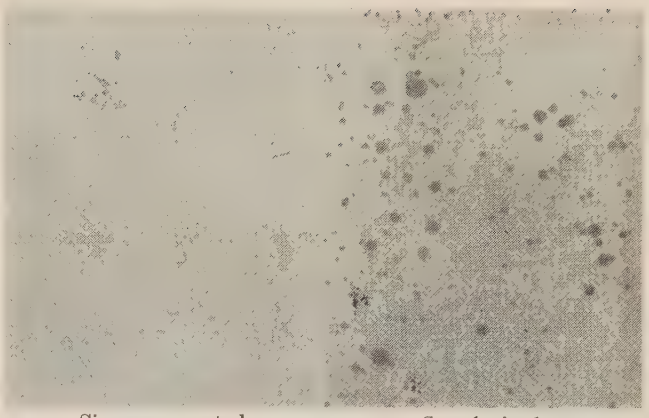


Fig. 6. Holdout of letterpress overprint varnish, low angle view showing gloss



Size press coated Starch sized

Fig. 7. Holdout of clear latex overcoating

Size press coating has also shown a definite advantage as a precoat for off-machine coating with colored pigments. One mill reports that with normal starch sizing there was a tendency for the colored pigments to agglomerate around the fibers giving the sheet a speckled appearance. With the use of a size press coated base stock, these agglomerates were practically eliminated.

Table V. Physical Properties of Conversion Coated Paper —Run No. 2

Raw stock	*Size press coated*	*Regular starch sized*
Basis weight, lb.....	60 (25 × 38—500)	54 (25 × 38—500)
Top coat, lb.....	20 C2S[a]	26 C2S
Basis weight (coated), lb.....	80	80
Caliper, in.....	0.0042	0.0042
Burst, p.s.i.....	28.7	27.5
Tear, MD/CD, g.....	51.0/57	51.5/56.2
Tensile, MD/CD, lb./1/2 in.....	14.3/5.8	12.2/7.8
Bekk smoothness, F/W	913/786	572/590
Brightness, F/W.....	75.5/75.0	76.5/76.5
Dennison wax, F/W..	6/6	6/4
K. & N. ink, F/W....	61.2/63.5	56.8/55.8
Gloss, % F/W.....	59/59.3	53/59
M.I.T. fold, MD/CD.	53.2/19.0	29.9/13.4
Opacity.....	96.8	98

[a] Casein portion of binder reduced 10%.

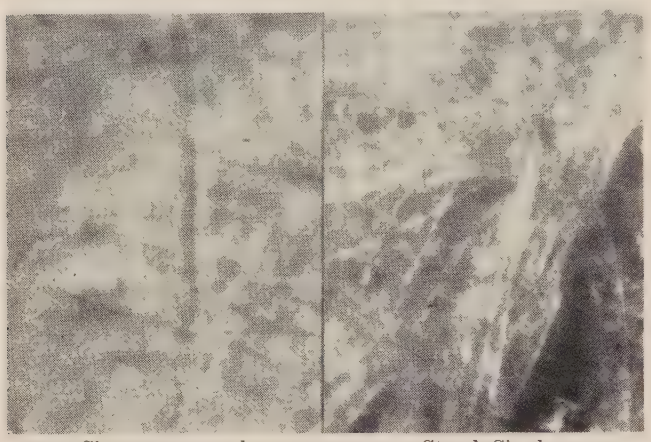
The question of cost savings can be clarified by calculations based on the initial run made by a Midwest mill. The cost of the size press coating containing 100 parts of clay, 20 parts of latex, and 20 parts of starch was 37 cents per 25 × 38—500 ream. Then including the 10.0% reduction in the casein portion of the binder and the 6-lb. reduction in off-machine cost, the net cost for the size press coating is 2 cents per 25 × 38—500 ream. Although this is an actual increase in cost, it should be remembered that the resulting sheet is double coated and superior in physical properties to the single-coated starch sized paper.

If the casein portion of the binder were reduced an additional 10%, the cost of the off-machine coating of the size press coated paper would be equal to the off-machine coating of the regular starch sized stock.

CONVERSION COATED STOCK PICKING RESISTANCE

Machine print tests (Warren tester) were made on off-machine coated paper obtained from another trial where the

pigmented size press coating consisted of 100 parts of clay, $17^1/_2$ parts of latex, and $17^1/_2$ parts of starch. The size press coated stock was coated with 20 lb. of off-machine coating and the regular starch sized stock with 26 lb. This resulted in a 70-lb. basis weight for both papers. A comparison of body stock picking resistance is shown in Fig. 3. The testing ink was I.P.I. heavy yellow which is a nondrying standard tack ink designed for machine print testers. The two strips at the bottom, comparing the size press coated and the starch



Size press coated Starch Sized

Fig. 8. Comparison of paper surfaces (150×)

sized papers, show that the starch sized stock picked severely at a testing speed of 720 r.p.m., while the size press precoated stock was unaffected. These tests indicate that even at the maximum speed of the pick tester (1440 r.p.m.), the size press precoated stock had only a very slight body stock pick.

K AND N INK RECEPTIVITY TESTS

The off-machine coated papers were compared for K and N ink receptivity according to TAPPI Routine Control Method RC-19 using the G.E. spectrophotometer at a wave length of 580 millimicrons (*5*, *6*). The size press precoated paper gave a value of 43.3 as compared to 36.3 for the paper with the normal starch sizing. In addition to the ink holdout, the paper with the size press precoating did not have the mottled appearance that was evident in the starch sized paper. This is shown photographically in Fig. 4.

HOLDOUT OF OVERCOATING LACQUER

The laquer holdout of raw stock can also be improved by the application of a pigmented size press coating. A comparison of letterpress overprint varnish holdout between size press coated stock and regular starch sized paper is shown in Fig. 5. The lower half of the photograph shows the varnished sides of the samples. The upper half is a view of the reverse sides of the same samples showing the relative degree of penetration. In Fig. 6 the same samples are shown taken at a lower angle to demonstrate the gloss of the varnished surfaces.

The letterpress overprint varnish was applied to commercially size press coated and starch sized paper in the laboratory. The size press coated paper with 3.3 lb. per 25 × 38—500 ream less lacquer had a Bausch and Lomb gloss of 62% as compared to 19% for the regular starch sized paper. Both papers had only a machine calender finish. After the varnish application and oven drying, the size press coated paper containing latex was also noticeably free from curl. In this particular case, a size press coating increased the cost of the raw stock by 35 cents per 25 × 38—500 ream with a basis weight increase from 44 to 50 lb. (25 × 38—500). The lacquer saving was at least $1.60 per ream using a laboratory drawdown. It is felt that a much greater saving could be realized in commercial applications.

HOLDOUT OF CLEAR LATEX OVERCOATING

The holdout of clear latex overcoatings with a size press coating is much greater than that obtained with normal starch sized paper. A comparison of pinholes in a clear latex overcoating applied over size press coated and starch sized paper is shown in Fig. 7. These raw stocks were the same ones used in the overprint varnish holdout comparison. With the laboratory drawdown of 14.1 lb. per 25 × 38—500 ream of plasticized Dow Latex 744-B on size press coated stock, the overcoating was pinhole free as indicated by flooding the surface with dyed turpentine. In comparison, the starch sized paper with a coating of 14.9 lb. per 25 × 38—500 ream had numerous pinholes. The latex overcoating weight had to be increased to 26 lb. on the starch sized paper before a pinhole-free coating was obtained. This is 12 lb. more than that required for pinhole freedom on the size press coated paper. From a cost standpoint with a size press coating increasing the cost of the raw stock by 35 cents per ream with basis weight increase from 44 to 50 lb. (25 × 38—500), an overcoating saving of $3.84 per ream was possible. Here again, the savings were obtained with overcoatings applied in the laboratory.

SIZE PRESS COATED PAPER FOR OFFSET PRINTING

Size press coatings containing latex offer the possibility of producing a paper having improved surface properties for printing. As shown in Fig. 8, which is a photomicrograph of a size press coated and a normal starch sized paper surface, the pigmented coating fills in the voids between the fibers. This increases the density of the surface, resulting in greater clarity of the printed matter.

The cost increase with a pigmented size press coating can be justified by replacing part of the fiber with coating. The cost of the coating is approximately 6 cents per lb. and is roughly equivalent to the price of good papermaking fiber.

In one case reported to us using an 80-lb. sheet, 10 lb. of fiber were replaced with 10 lb. of coating. The size press coating formulation was 100 parts of clay, 15 parts of starch, and 15 parts of latex. It was found that the bursting strength did not change appreciably. The resistance to air penetration test showed an increase from a normal test of 140 to 1000 sec. on one grade and from 60 to 480 sec. on another grade. These sheets printed very well by the four-color offset process. Excellent ink holdout and good register were obtained because the paper lay flat and apparently was not affected by moisture. In subsequent size press coating runs, the adhesive was reduced to 25% of the clay solids with satisfactory results.

CONCLUSIONS

The application of a pigmented size press coating offers a number of advantages, both from a quality and cost standpoint, as a precoat for off-machine pigmented coatings, lacquer coatings, and clear latex overcoatings. Satisfactory paper for offset printing can be made using size press coatings containing latex without additional coating operations.

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An Approach to the Evaluation of Coated Paper Smoothness

LOUIS J. SCHEID and ARTHUR H. HUPP

THE adjective "smooth" has been defined as "having an even surface; devoid of surface roughness" (*1*). Therefore, the measurement of smoothness can be considered as the estimation of the magnitude of surface roughness. In the practical sense, ultimate smoothness of coated paper may be defined as that degree of freedom from surface roughness which will permit perfect contact between printing medium and coated surface. As thus defined, coated paper smoothness evaluation should include neither gross deviation from planarity (which are functions of raw stock formation, uniformity of caliper, calendering, and the like) nor minute deviations which do not affect printing contact. To further refine the definition, coated paper smoothness evaluation should be independent of secondary defects (such as pinholes, small color lumps, etc.) which may affect printing quality in practice, but are actually correctable flaws in the primary printing surface.

Three general types of measurements—air flow, stylus, and optical—have been used to estimate coated paper smoothness. Numerous articles have appeared in the literature covering the good and bad features of existing instruments of all types and the interrelationships of "smoothness" and "softness" (*2–7*).

During the Graphic Arts Session of the National TAPPI Convention of 1952 S. M. Chapman presented a summary of his optical smoothness tester. In brief, this method is based on the use of a glass prism (with or without a transparent liquid on its lower face) which is pressed against the paper to

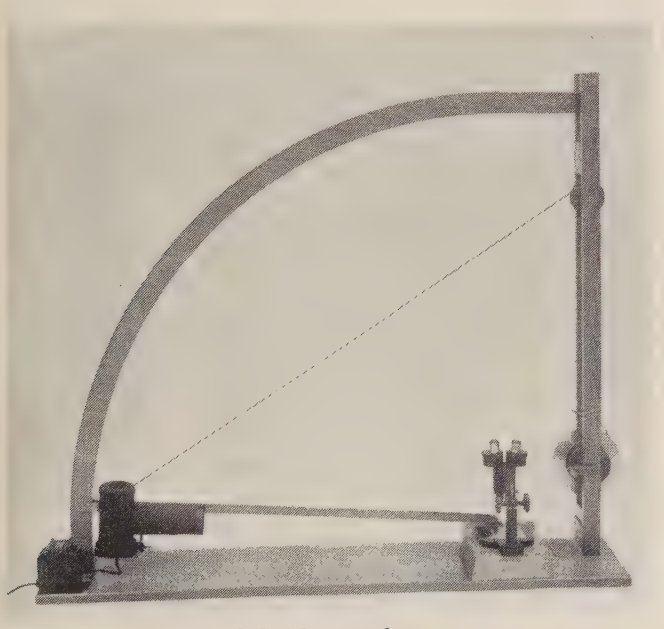

Fig. 1. Scheid smoothness tester

be tested. The prism is illuminated and the intensities of the light specularly and diffusely reflected from its lower face are measured. The ratios of these intensities are dependent upon the proportion of the lower face of the prism in contact with the paper surface (*6*).

Discussions following Mr. Chapman's summary indicated the method had many advantages but suffered from the following weaknesses: (1) affected by gross deviations from planetary, (2) lacked sensitivity to differences in depth or height of surface imperfections, and (3) required considerable time per evaluation.

Subsequently the senior author designed a crude optical smoothness tester as shown in Fig. 1. The unit has been in operation at Watervliet Paper Co. for over 1 yr. and has

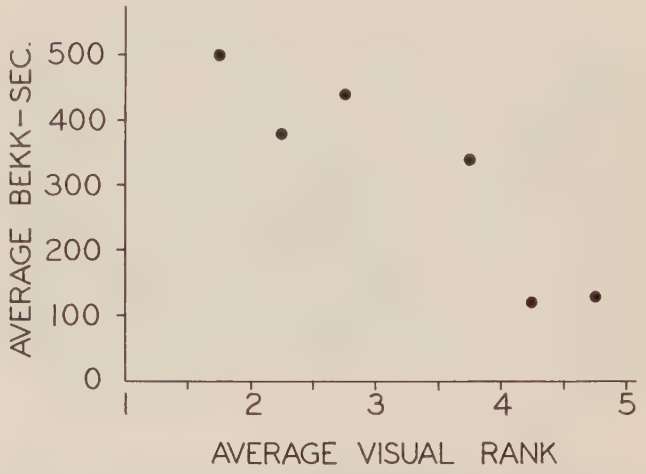

Fig. 2 Relationship between Bekk smoothness and visual ranking of coated paper surface

proved valuable as both a research and control instrument in the evaluation of coated paper smoothness.

As can be readily seen by reference to the photograph the unit is extremely simple. The sample to be tested is inserted on the square stage of the binocular microscope which is so placed that a parallel beam from an optical disk illuminator with a concentrated filament incandescent lamp intersects the midpoint of the field. The illuminator is mounted on a hinged lever which can be passed through an arc of 90° by means of a hand crank. The axis of the beam of light, the axis of the optical field, and the axis of rotation intersect within limits. The arc is calibrated in degrees from the horizontal axis. When the paper is illuminated by a grazing beam at a low angle of incidence a pattern of light and shadowed areas can be detected through the microscope which is equipped to magnify 30×. Upon increasing this angle, an increase in spectral reflectance occurs, thus decreasing the sharpness and number of light and shadowed areas.

In the normal range of coated paper surfaces, several different end points can be noted, all dependent on various optical illusions caused by these changes in light and shadow relationships. Two end points have been most widely used at Watervliet, the first involving an optical illusion of loss of depth of surface irregularities and the second involving a sharp decrease in the resolution of surface imperfections. These have been respectively identified as Scheid 1 and Scheid 2 smoothness values (in degrees deflection from horizontal).

PROCEDURE FOR EVALUATION

To evaluate the instrument and reliability of these smoothness values ten random samples of each of 24 coated papers were arranged in a statistically random order and coded in a manner to prevent identification of sample. Each of two operators independently determined Bekk, Scheid 1, and Scheid 2 smoothnesses and also ranked the surface smoothnesses visually from 0 to 5 with 0 representing a perfect printing surface and 5 the most serious surface roughness observed in any commercially available samples of coated printing papers.

As would be expected, considerable differences existed between operators in visual ranking of the surfaces examined although each operator was reasonably consistent in his ranking

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Table I. Schematic Representation of Method of Assembling Data for Smoothness Test Evaluation

Paper	*1*	*2*	*3*	*K − 1*	*K*
Sample—*a*	Xa_1	Xa_2	Xa_3	$Xa(k-1)$	Xak
Sample—*b*	Xb_1	Xb_2	Xb_3	$Xb(k-1)$	Xbk
Sample—*c*	Xc_1	Xc_2	Xc_3	$Xc(k-1)$	Xck
Sample	...	...	...	...	...
Sample	...	...	...	...	...
Sample	...	...	...	...	...
Sample	...	...	...	...	...
Sample—*n*	Xn_1	Xn_2	Xn_3	$X_{n(k-1)}$	X_{nk}
Sample range	R_1	R_2	R_3	$R_{(k-1)}$	R_k
Sample average	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_{(k-1)}$	$\bar{X}_k$

Average sample range $(\bar{R}) = \dfrac{(R_1 + R_2 + R_3 \ldots\ldots\ldots\ldots R_k)}{K}$

of the ten samples of each of the coated papers. It was thus necessary to separate the data into broad class intervals of visual ranking to more clearly indicate the general relationships between the various smoothness tests and the true surface quality of the coated paper. Figures 2, 3, and 4 show that the same general level of correlation exists for all three methods.

REPRODUCIBILITY OF SMOOTHNESS TESTS

The various data were assembled according to the schematic arrangement shown in Table I. Average reproducibilities of tests (as standard deviations) were estimated from within sample ranges (*8*, *9*), with the following results:

Test	*Standard deviation*	*Coefficient of variation, %*[a]
Bekk	95 seconds	24
Scheid 1	2.0 degrees	10
Scheid 2	2.8 degrees	9

[a] Coefficient of variation = (100 × standard deviation) ÷ average test value.

Effect of Operator on Test Value

Between operator reproducibility was excellent for both Bekk and Scheid 1 tests but poorer (although reasonable) for Scheid 2. Work is currently in progress to determine reasons for these inconsistencies. Because of the excellent reproducibility of both testers within samples it is expected that the differences are likely to be due to misinterpretation of end point.

CONCLUSIONS

After a year's experience with the Scheid tester, the following observations have been made:

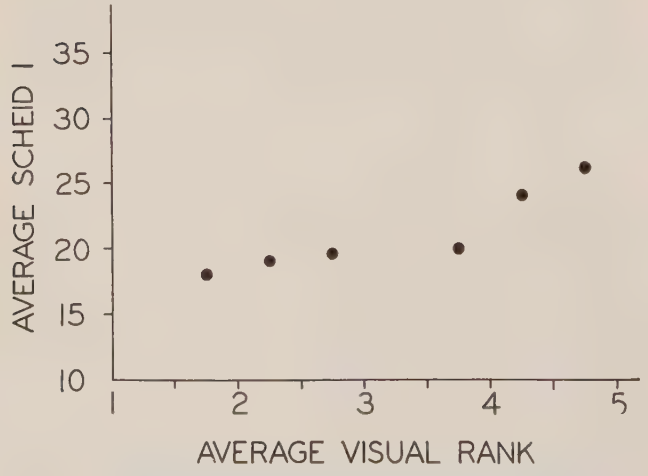

Fig. 3 Relationship between Scheid 1 end point and visual ranking of coated paper surface

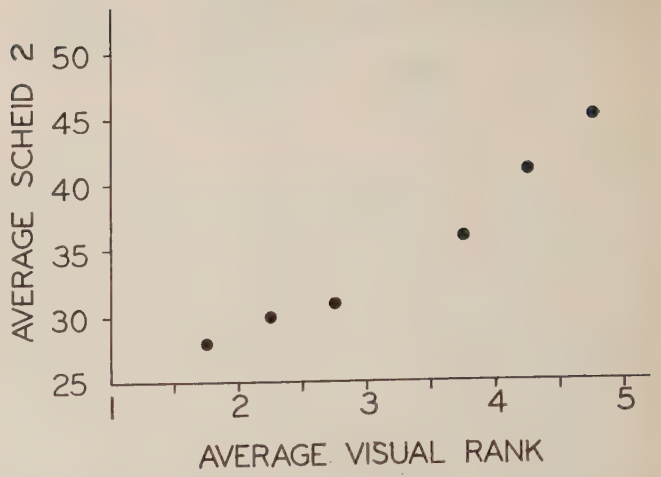

Fig. 4. Relationship between Scheid 2 end point and visual ranking of coated paper surface

1. The Scheid tester in its present form has been highly satisfactory in evaluating coated papers of the type produced by Watervliet. Limited experimentation has indicated that the instrument and end points used may not be as applicable to machine coating or uncoated paper surfaces.

2. Reproducibility of testing is at least as good as with the Bekk tester. Possibly with further refinements, such as those included in the Graff Variable Angle Surface Illuminator (*10–13*) an increase in reproducibility can be shown.

3. Within limits, depth of cavities can be considered by choice of end point. In addition, both continuous and noncontinuous cavities enter into the test whereas in air type testers the continuous cavities carry the greatest significance. It should also be noted that errors due to air leakage through pores of paper are eliminated.

4. Papers can also be evaluated on this optical tester without regard to gross imperfections (raw stock formation, color lumps, and pinholes) which should be considered as correctable flaws in the primary printing surface. Likewise, small imperfections which do not affect printing quality can be ignored.

In view of the performance of a nonprecision instrument of this type further experimentation seems indicated. Particularly it would be desirable to have further data available on the effect of such factors as magnification, precision, color of illuminant, etc., on the end point and the precise degree of relationship between end points and actual printability as determined by controlled printing.

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Progress Report on the Development of a Calcium Carbonate for High Gloss Paper Coatings

R. W. HAGEMEYER and GEORGE E. HALL

In the mid-thirties when calcium carbonate was growing in importance as a pigment for paper coating, Wyandotte Chemicals Corp. entered the calcium carbonate field primarily to produce a high-quality paper coating material. Our basic raw materials and in-the-plant processes were such that we could choose between any of the three common methods of producing precipitated calcium carbonate, namely, causticization of milk-of-lime with soda ash, carbonation of milk-of-lime with either stack or kiln gas, or by the reaction of calcium chloride and soda ash, which are made in another of our manufacturing operations. We chose the latter of these three processes for reasons which can best be illustrated by checking the flow diagram (Fig. 1).

All precipitated calcium carbonates start from limestones similar to those which are supplied in the form of ground whiting for use in paper coatings. These are calcined in the lime kilns bringing about the decomposition of the limestone into carbon dioxide gas and quicklime. The gas coming out of the top of the kiln is cooled and may be scrubbed or not, depending on its purity and the quality desired, for use later in the process. The quicklime from the bottom of the kiln is given a rough screening before being slaked with water to form the milk-of-lime. This suspension is then pumped into settling tanks where most of the impurities are removed and discarded. Up to this point all three processes are the same.

From here the first two reaction processes are rather straightforward, namely, bubbling the kiln gas through the milk-of-lime in a suitable carbonator, or mixing of the milk-of-lime and sodium carbonate in the processing equipment. In the former, the particle size and particle shape can be controlled by varying reaction temperatures, reaction rates, and by the use of various additives. In the latter process the dominant factor is the production of caustic soda, so the possibilities for controlling the production of the calcium carbonate are minimized. In the third process the milk-of-lime is reacted with ammonium chloride freeing the ammonia as a gas and forming a calcium chloride solution. The colloidal impurities that are present in the milk-of-lime and in the final calcium carbonates as made by the first two processes can be readily filtered from the calcium chloride solution, thus providing a very pure source of calcium ion. The calcium chloride solution is then reacted with a soda ash solution of equal purity to form calcium carbonate. This process can readily be controlled by varying addition times, agitation rates, and

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Table II. Physical Properties of Purecal M-Fine

Optical cell brightness	100
Packed density, g./cc.	0.43
325-Mesh kneaded residue, %	0.10
Slip value, g. H_2O/100 g. $CaCO_3$	182
Oil absorption, g. oil/100 g. $CaCO_3$	57
Free lime, %	1.2
pH	10.0

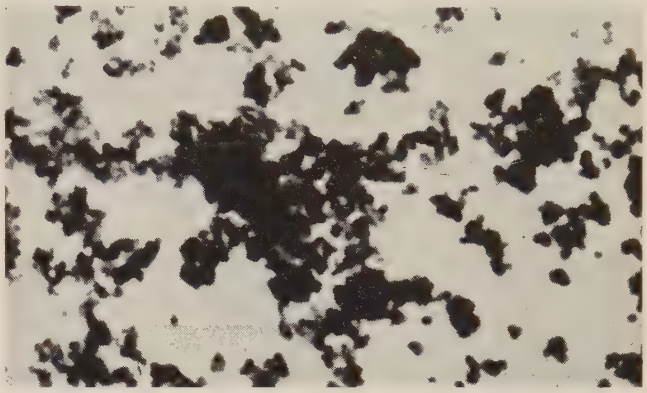

Fig. 2. Purecal U (0.036–0.040 mu) (×30,000)

Table I. Paper Coating Properties of Various Pigments

Formula: pigment, 100; latex (dry), 5; casein, 5; water, 100

Pigment	*Particle size, mμ*	*Crystal type*	*Stormer viscosity, KU*	*B. & L. brightness*	*Contrast ratio*
Purecal D	8–10	Calcite	64	88.8	0.773
Purecal M	0.15–0.35	Calcite	85	94.2	0.949
Ppt. $CaCO_3$A	3–5	Calcite	62	87.4	0.719
Ppt. $CaCO_3$B	1–2	Aragonite	148	92.8	0.930
Water ground whiting	1–3	...	62	89.6	0.862
Ppt. $CaCO_3$C	1–2	Mixture	122	93.2	0.931
Blanc fixe	2–5	...	57	89.8	0.804
Clay no. 2	2–4	...	149	87.2	0.925
Titanium calcium pigment	0.25–0.45	...	55	94.0	0.932
Titanium dioxide	0.12–0.35	...	64	95.0	0.987

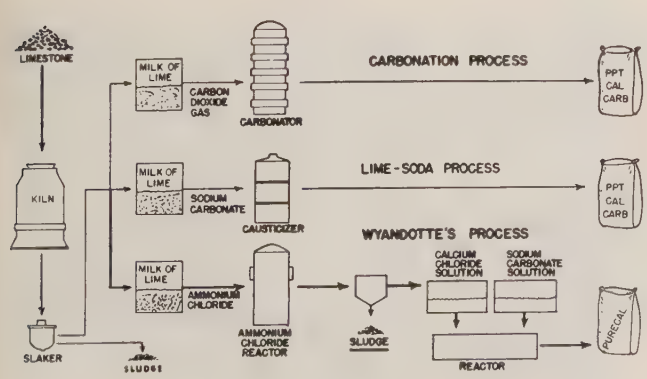

Fig. 1. Manufacturing processes for precipitated calcium carbonate

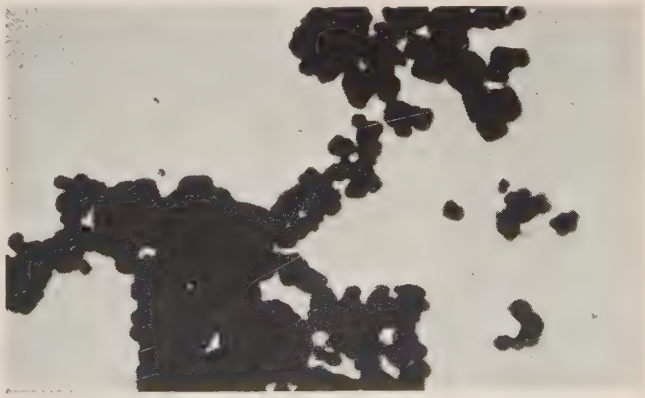

Fig. 3. Precipitated $CaCO_3$ (0.060–0.075 mu) (×30,000)

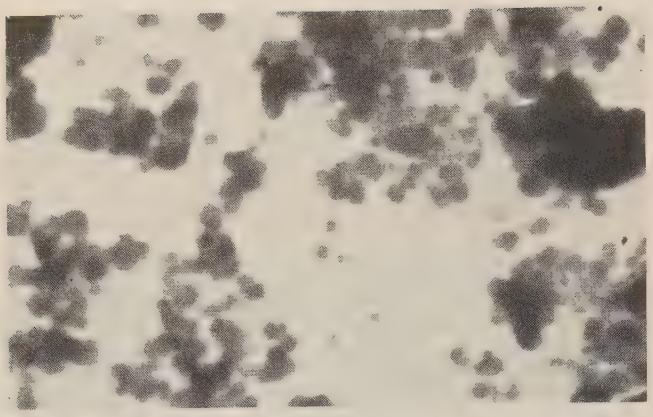

Fig. 4. Precipitated $CaCO_3$ (0.075–0.100 mu) (×30,000)

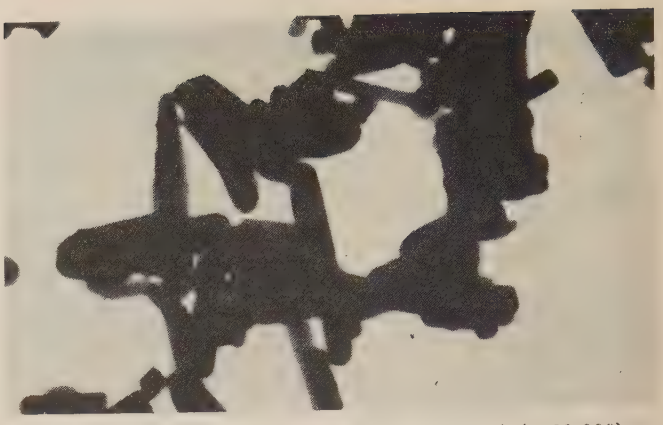

Fig. 6. Precipitated $CaCO_3$ (0.15–0.45 mu) (×30,000)

reaction temperatures. In addition, the advantages gained by using very carefully controlled raw material sources all add up to the possibility of making a very uniform and pure final product. In view of the many evident advantages of this third process together with some advantages that we were yet to learn, Wyandotte adopted this method for the manufacture of Purecal M.

Before going into the present development work it might be well to touch briefly on the differences in particle size, shape, and flow properties of some calcium carbonates which are presently used in paper coating. The accompanying photomicrographs (Figs. 2–14) show the difference in particle size and particle shape of some typical materials. Actually the particle sizes of common paper coating pigments range anywhere from 30 on down to less than 0.2 mu. In general the more highly refined products have a much narrower particle size range. You will note also that in the precipitated products there are two basic shapes, the needle-shaped crystal and the cubical-shaped crystal.

Naturally with these wide differences in particle sizes and particle shapes and without compensating for the difference in chemical properties, you would expect to get markedly different flow properties and such is the case. Also, the differences in particle size and chemical pureness also have an effect on the coating properties of these various calcium carbonates as shown in Table I.

As a result of these data, we have plotted (Fig. 15) a curve of relative hiding power as a function of particle size. These figures were obtained using five standard calcium carbonates having essentially the same chemical properties and dry powder brightness but of varying particle size. It is interesting to note that at a particle size corresponding to approximately half the wavelength of the visible spectrum (0.2 to 0.3 mu) maximum hiding is obtained. The particle size of Purecal M, titanium dioxide, and titanium-calcium pigment are all in this range as can be seen from the electron photomicrographs (Figs. 5, 16, 17). One explanation offered for this phenomenon is that the reflected light is diametrically out of phase with the incident light giving maximum destructive interference.

The major point to get out of this background material is that there are wide differences in calcium carbonates which, in turn, will have a definite effect on their performance in different coating colors. Knowing the effect of particle size, particle shape, uniformity, and whiteness of the calcium carbonate on the final coating color, it should be possible to select a calcium carbonate that will give the properties the paper coater is after, or if none of the present products will do the job, design one that will solve the problem.

This was the case that came up 3 years ago when a member of one of the major paper companies approached Wyandotte Chemicals Corp. asking if we had considered producing a calcium carbonate that gave higher gloss to coatings than could be obtained with Purecal M. We had done some work on this problem several years ago but never followed through on it. We decided to investigate further the possibilities of developing such a calcium carbonate. In resuming this development work in our laboratory we found first that gloss of a calcium carbonate was a function of particle size; the finer the particle the higher the gloss. We thought also that gloss was a function of particle shape but since we could not obtain any needlelike crystals in the same particle size range in which we were working, we could not confirm this theory. The initial solution to the problem, therefore, was simple, make the finest particle size calcium carbonate that we can and obtain the maximum gloss. However, to paraphrase the axiom, "What looks good on paper oftentimes won't work in practice," what looked good in theory didn't work on paper. Practical application of the theory was upset by the fact that as particle size decreases, tendency to agglomerate, as well as hardness of the agglomerate, increases. Our initial laboratory evaluations were done on our Purecal U, a calcium carbonate manufactured primarily for the rubber industry and having an ultimate particle size of 0.036 mu. Surprisingly enough in running a wet residue test on this material, upwards of 15% residue was retained on a 325-mesh screen, the wire openings

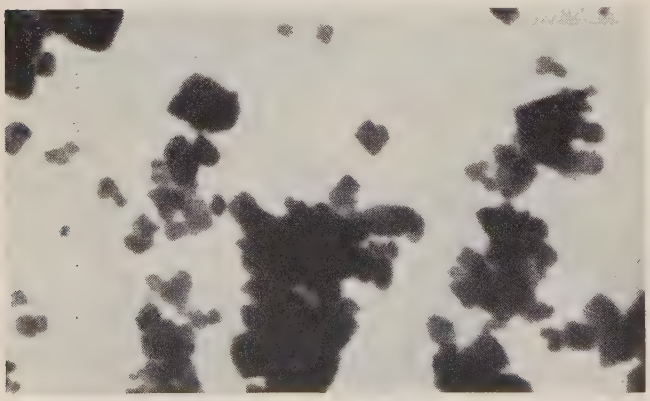

Fig. 5. Purecal M (0.12–0.32 mu) (×30,000)

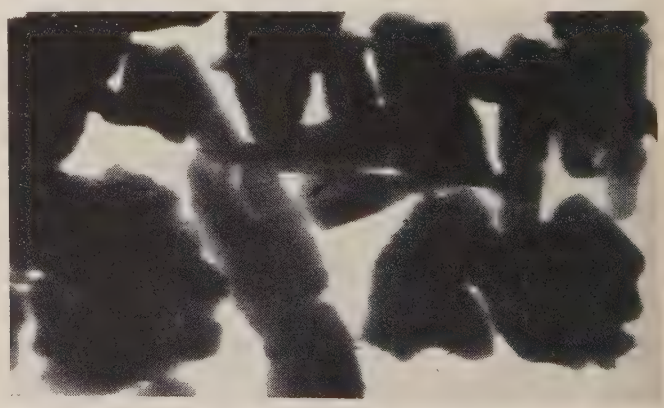

Fig. 7. Precipitated $CaCO_3$ (0.50–1.35 mu) (×5200)

Fig. 8. Precipitated $CaCO_3$ (1.0–4.0 mu) (×5200)

being 44 mu. These rather hard agglomerates could not be dispersed without considerable difficulty and even when completely dispersed tended to reagglomerate to such an extent that the effective particle size on the paper was much greater than that obtained when using even some of the coarse ground limestones. Actually some of the sheets closely resembled sandpaper. Since we knew that raising the particle size would decrease the number and the hardness of the agglomerates we gradually increased our particle size until we reach what we believe to be optimum particle size for the adhesive materials presently available. When new adhesive systems and wetting agents are introduced, possibly the particle size can be decreased.

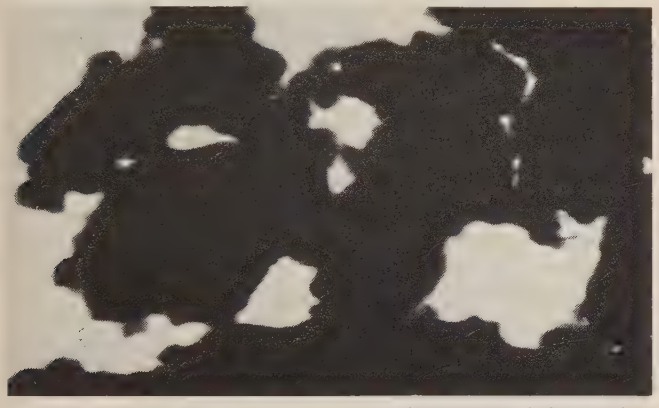

Fig. 9. Water ground limestone (1.0–3.0 mu) (×5200)

The particle size we gelled on is just under a tenth of a micron ranging from 0.085 up to 0.095 mu. The properties of this product which we temporarily designated as Purecal M-Fine are shown in Table II.

Having gelled on the particle size for the material, we were ready to embark on our paper testing work. The properties we expected to obtain were higher gloss, better finish, higher ink receptivity, higher water absorption with its adverse

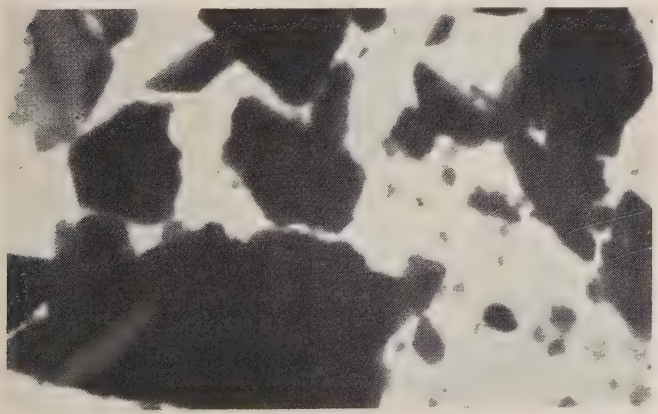

Fig. 10. Water ground limestone (1.5–5.0 mu) (×5200)

Fig. 11. Purecal D (8.0–10.0 mu) (×5200)

effect on coating solids, and higher adhesive demand with its adverse effect on coating costs. Actually we expected by this time to have a complete report available on this product, but the work, while progressing rapidly, has uncovered several things which we did not anticipate and which will have to be thoroughly investigated before the problem is solved.

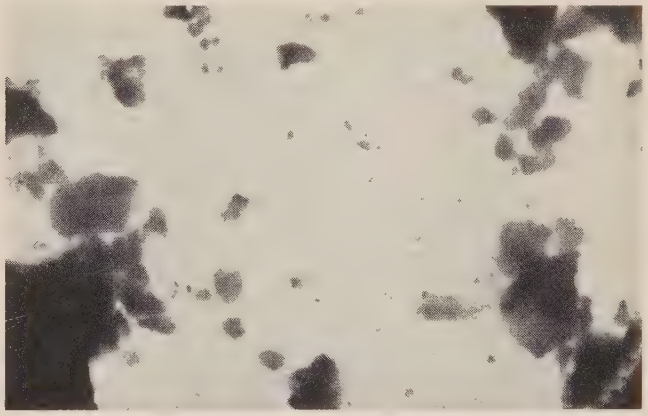

Fig. 12. Dry ground limestone (10–30 mu) (×5200)

Since laboratory results, while indicative are rarely conclusive, we have not bothered to include the data obtained on our laboratory handsheets. The results shown in Table III are representative of some of the results obtained in mill trials. These trials were run in different mills using various

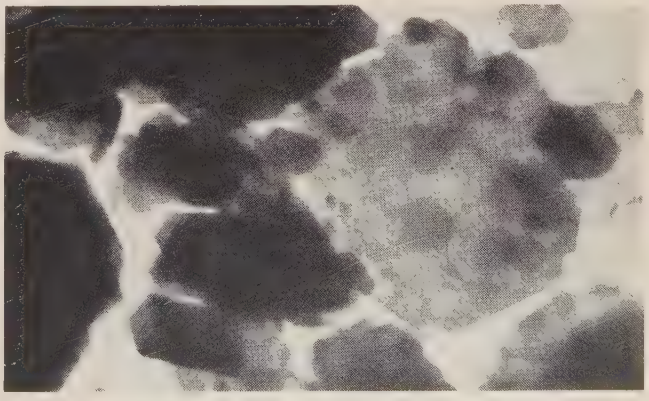

Fig. 13. No. 1 clay (0.2–1.0 mu) (×5200)

Table III. Formulations

	1	1x	2	2x	3	3x	4	4x	5	5x	6	6x
Purecal M	50	..	25	..	15	..	20	..	25	..	25	..
Purecal M-Fine	..	50	..	25	..	15	..	20	..	25	..	25
Clay English	..	..	..	..	85	85	..	..	..	..	..	..
No. 1	50	50	45	45	..	..	80	80	55	55	55	55
No. 2	..	..	30	30	..	..	..	..	..	..	..	..
Pigment X	..	..	..	..	..	..	..	..	20	20	20	20
Adhesive(casein-latex)	15	15	15	15	15	15	15	15	15	15	15	15
Calgon T (1% on $CaCO_3$)	0.5	0.5	0.25	0.25	0.15	0.15	0.2	0.2	0.25	0.25	0.25	0.25
					Physical Properties							
Brightness, B. &. L.	94.6	94.8	90.7	90.6	94.2	94.2	94.0	94.6	93.0	93.5	94.8	94.3
Sheen (75° Hunter)	57	67	52	71	65	79	75	72	45	53	37	41
Gloss (60° Ingersoll)	72	80	75	83	82	87	84	84	70	74	65	66
Opacity	96.3	96.5	96.6	97.0	96.1	96.1	95.2	95.4	96.5	97.0	97.4	97.4
Smoothness, Bekk	1107	1432	995	1311	>1000	>1000	1600	1230	800	819	448	592
Ink receptivity, K. & N.	2.34	2.26	2.05	2.07	1.77	1.73	1.88	1.88	2.27	2.38	2.24	2.30
Wax pick	3A	2A	4A	4A	6A	7A	5A	6A	5A	5A	5A	6A

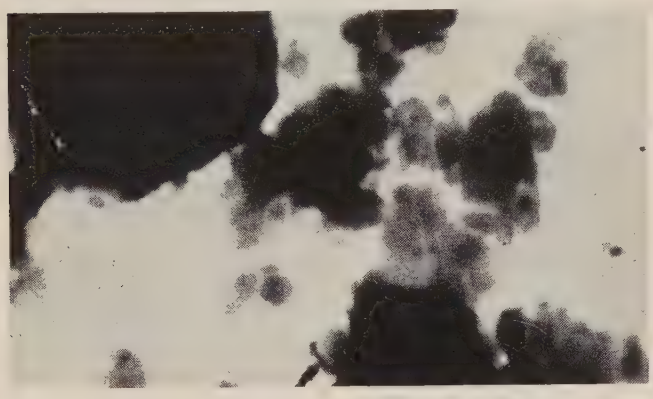

Fig. 14. Clay (0.3–2.0 mu) (×5200)

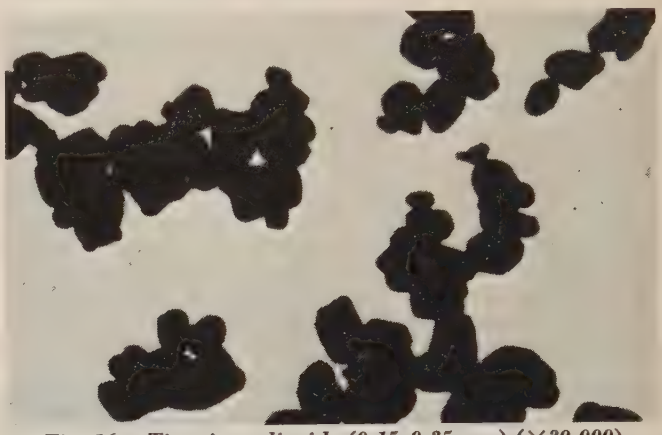

Fig. 16. Titanium dioxide (0.15–0.35 mu) (×30,000)

weights of both rawstock and coating. All the papers were brush coated at between 38 and 46% total coating solids. For any one trial, the only formulation variable was in the replacement of Purecal M with Purecal M-Fine. In general, the coating colors containing Purecal M-Fine had to be run at 3 to 5% lower coating solids than the control formula. Also, it was necessary to use Calgon T to obtain a proper dispersion of the fine particle size calcium carbonate.

Samples of coated paper from the above trials were printed by both letterpress and offset processes. In almost every case the sheets having Purecal M-Fine in the coating had better register, greater depth, more pronounced high lights, and sharper detail. Also, examination of the coated surface indicated better coating lay and less coating pattern for the sheets coated with the finer particle size Purecal. This could be the result of the thixotropic flow properties of Purecal M-Fine, whereas Purecal M tends to be dilatant.

The results obtained thus far show that when Purecal M-Fine is substituted for Purecal M the resultant sheet will have: (1) higher gloss and sheen, (2) better coating lay and less pattern, and (3) improved printing properties.

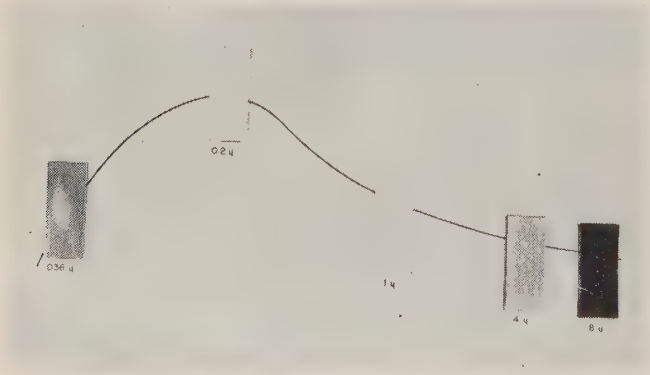

Fig. 15. Hiding power versus particle size

There is still a considerable amount of work yet to be done on this project. It may be that a different type coating formulation will have to be developed to take maximum advantage of the properties of Purecal M-Fine. All test work thus far has consisted of direct substitution for Purecal M in standard coating formulas. Also, most of the work has been done in conversion coating at relatively low solids where little if any benefit could be gained from the thixotropic flow properties of Purecal M-Fine. Actually, we expect this pigment to show up best in machine coating operations. Another possibility yet to be explored is modification of the pigment itself. This could be done by changing the pH, the addition of a coating agent, or similar measures.

Some of this work has been done, but too recently to be included in this paper. A good portion of the remainder is scheduled for the near future. We hope to have a complete report available for presentation next year.

The authors would like to acknowledge the assistance of Helm G. Schwalbe of the Mead Corp., who has helped in this work from the beginning, as well as that of R. N. Thompson of Calgon, Inc., the various paper mills who have cooperated in the mill runs, and the help of Charles D. MacIntosh of our Research Dept. who did most of the evaluation work.

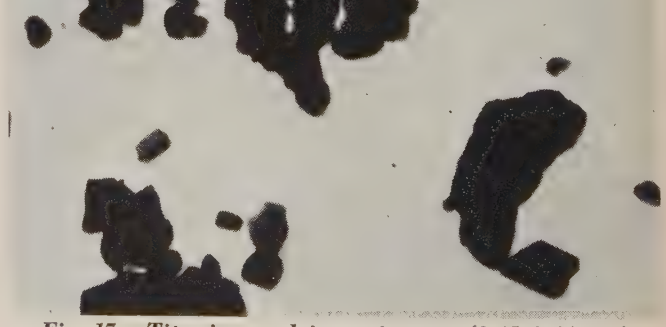

Fig. 17. Titanium-calcium pigment (0.15–0.45 mu) (×30,000)

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NATIONAL MEETINGS

Third Corrugated Containers Conference, Statler Hotel, New York, N. Y., October 15–16, 1953.

Eighth Engineering Conference, Sheraton-Mt. Royal Hotel, Montreal, P. Q., October 26–29, 1953.

Seventh Alkaline Pulping Conference, Rice Hotel, Houston, Texas, November 18–20, 1953.

Thirty-ninth Annual Meeting, Commodore Hotel, New York, N. Y., February 15–18, 1954.

Fifth Coating Conference, Poland Spring House, Poland, Spring, Me., May 24–26, 1954.

COATINGS FOR BOX BOARD

In the period 1933–36, lacquers were applied almost exclusively to clay coated box board by the sheet varnishing method, and over printed matter (e.g. folding cartons). The object of lacquering was entirely *decorative.*

This operation declined during the following ten years as improved gloss inks and "press" varnishes were developed, which could be applied with printing equipment and required no dryers or solvent removal.

But since 1946, the "lacquering" of box board has again become a large scale coating operation. The objectives in coating have now become largely *functional* (i.e. abrasion resistance, alkali fastness, water vapor impedance, greaseproofing, ability to go through hot packing, etc.)

New equipment has become available capable of applying coatings to board at very high speed and low cost,—frequently as an integral part of the printing and converting operations. Silicated, starched and latex sized boards are now equivalent to clay.

"Lacquer" for box board no longer means only nitrocellulose based coatings, but includes a variety of film formers. PYROXYLIN PRODUCTS, INC., supplies lacquers for box board formulated from synthetic and natural resins, rubbers, oils and carbohydrates, as well as cellulose derivatives. These compositions are suitable for use on web and knife coaters, gravure and aniline presses, gang spray, and the conventional sheet varnishing machines.

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American Cyanamid Co. (Calco Chemicals Div.) ... 53 A–54 A
American Cyanamid Co. (Industrial Chemicals) ... 67 A
Ansul Chemical Co. ... 114 A
Antara Chemicals Div. (General Dyestuff Corp.) ... 71 A
Appleton Machine Co. ... 103 A
Appleton Woolen Mills ... 111 A
Atlantic Refining Co. (Industrial Products) ... 3 A

Babcock & Wilcox Co. ... 13 A
Bagley & Sewall Company ... 93 A
Baltimore & Ohio R. R. (Freight Dept.) ... 2nd Cover
Bauer Bros. Co. ... 97 A
Beloit Iron Works ... 1 A
Bird Machine Co. ... 75 A
Black-Clawson (Shartle & Dilts) ... 79 A
Bolton & Sons Inc., John W. ... 29 A
Brown Co. ... 101A
Buffalo Forge Co. ... 85 A
Buffalo Pumps, Inc. ... 70 A
The Burtonite Co. ... 125 A
Butterworth & Sons, H. W. ... 115 A

Cameron Machine Co. ... 62 A
Cities Service Oil Co. ... 63 A
Columbia-Southern Chemical Corp. ... 4th Cover

Dicalite Division (Great Lakes Carbon Corp.) ... 12 A
Dorr Co. ... 91 A
Downingtown Mfg. Co. ... 59 A
Draper Brothers Co. ... 46 A
Du Pont de Nemours & Co., Inc., E. I. (Aromatics) ... 105 A
Du Pont de Nemours & Co., Inc., E. I. (Electrochemicals) ... 45 A
Du Pont de Nemours & Co., Inc., E. I. (Grasselli) ... 23 A
Du Pont de Nemours & Co., Inc., E. I. (Pigments) ... 35 A
Du Pont de Nemours & Co., Inc., E. I. (Vinyl Products) ... 77 A

Eastwood-Nealley Corp. ... 21 A
Ebasco Services, Inc. ... 124 A

Foxboro Co. ... 52 A
Fuller Co. ... 60 A

Geigy Co., Inc. ... 126 A
General American Transportation Corp. ... 64 A
Glidden Co., The ... 48 A

Heppenstall Co. ... 20 A
Hermann Manufacturing Co. ... 118 A
Hooker Electrochemical Co. ... 47 A
Huber Corp., J. M. ... 4 A
Hubinger Co., The ... 95 A
Huyck & Sons, F. C. ... 99 A

Improved Machinery, Inc. ... 31 A
Infilco, Inc. ... 43 A

Johns-Manville Corp. (Celite) ... 69 A
Johns-Manville Corp. (High Temperature) ... 81 A
Johnson Corp., The ... 124 A
Jones & Sons Co., E. D. ... 10 A–11 A

Kelco Co., The ... 27 A

Langston Co., Samuel M. ... 68 A
Linderman Devices, Inc. ... 127 A
Lockport Felt Co. ... 8 A

Magnus Chemical Co. ... 116 A
Mallinckrodt Chemical Works ... 120 A
Midwest-Fulton Machine Co. ... 126 A
Mixing Equipment Co., Inc. ... 65 A
Monsanto Chemical Co. (Merrimac Div.) ... 19 A
Morden Machines Co. ... 17 A
Mt. Vernon-Woodberry Mills (Turner-Halsey Co.) ... 2 A

National Aluminate Corp. ... 41 A
National Aniline Division (Allied Chem. & Dye Corp.) ... 61 A
National Forge & Ordnance Co. ... 125 A
National Starch Products, Inc. ... 9 A
Nichols Engineering & Research Corp. ... 83 A
Nopco Chemical Co. ... 51 A

Pandia, Inc. ... 25 A
Perkins & Son, Inc., B. F. ... 122 A
Permutit Co., Inc. ... 18 A
Pusey & Jones Corp. ... 36 A
Pyroxylin Products, Inc. ... 184 A

Raybestos-Manhattan, Inc. (Manhattan Rubber Div.) ... 33 A
Reichhold Chemicals, Inc. ... 39 A
Rice Barton Corp. ... 49 A
Rohm & Haas Co. ... 57 A
Roots-Connersville Blower (Div. of Dresser Industries Inc.) ... 72 A

Sandy Hill Iron & Brass Works ... 120 A
Smith Corp., A. O. ... 58 A
Solvay Process Div. (Allied Chem. & Dye Corp.) ... 113 A
Sprout, Waldron & Co. ... 107 A
Standard Oil Co. (Indiana) ... 109 A
Stebbins Engineering & Mfg. Co. ... 89 A
Sutherland Refiner Corp. ... 6 A–7 A
Swift & Co. ... 37 A

Taylor Instrument Companies ... 66 A
Taylor-Stiles & Co. ... 123 A
Texas Gulf Sulphur Co. ... 56 A
Thwing-Albert Instrument Co. ... 121 A
Titanium Pigment Corp. ... 3rd Cover

Valley Iron Works ... 87 A
Vanderbilt Co., Inc., R. T. ... 15 A
Virginia Smelting Co. ... 117 A

Waldron Corp., John ... 119 A
Wallace & Tiernan Co., Inc. ... 50 A
Weyerhaeuser Timber Co. (Pulp Div.) ... 55 A
Witco Chemical Co. ... 122 A

PROFESSIONAL SERVICES

Chemical Linings ... 183 A
Grellet N. Collins ... 183 A
The H. K. Ferguson Company ... 183 A
G. D. Jenssen Co., Inc. ... 183 A
Alvin H. Johnson & Co., Inc. ... 183 A
Knowles Associates ... 183 A
Chas. T. Main, Inc. ... 183 A
Myers & Addington ... 183 A
Roderick O'Donoghue ... 183 A
Paper and Pulp Testing Laboratories ... 183 A
Pfeifer & Shultz ... 183 A
J. E. Sirrine Co. ... 183 A

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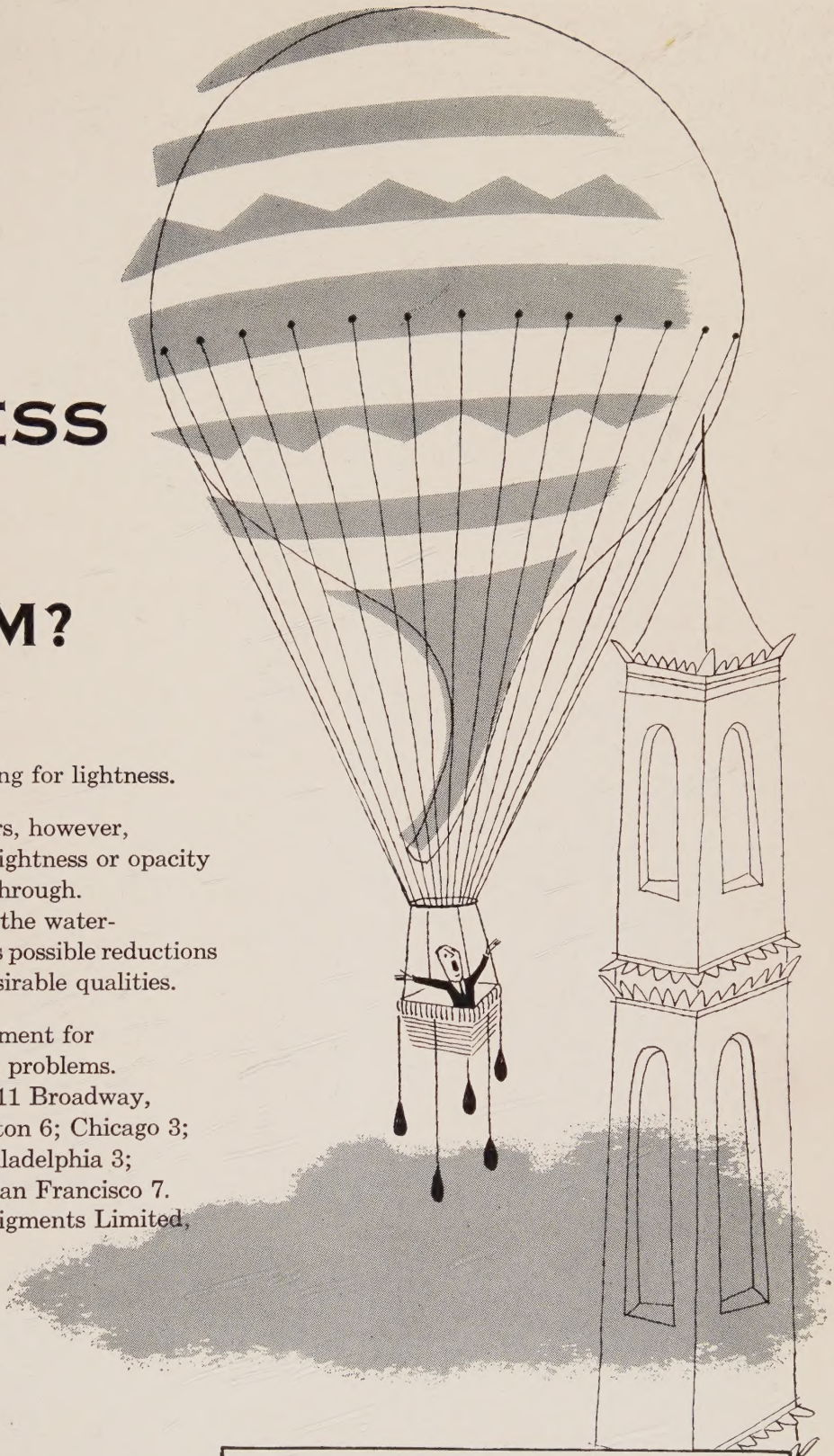

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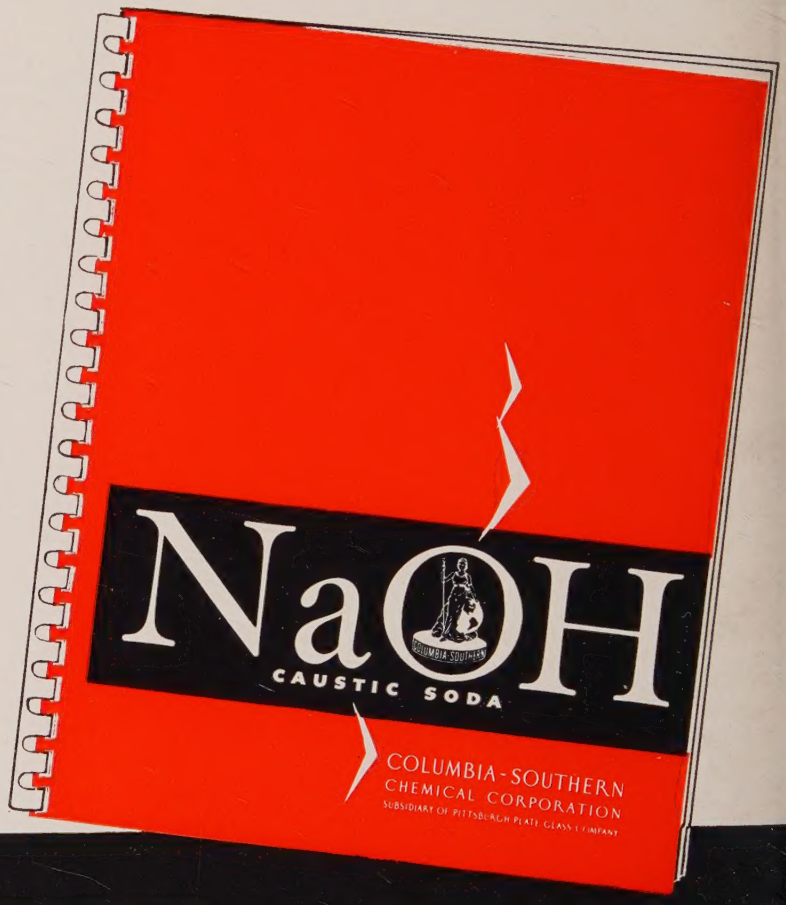

TABLE OF CONTENTS:

History, Production and Uses of Caustic Soda
The Manufacture
Forms and Grades
Shipment
Comparative Economics of Solid and Liquid
Precautions in Handling
Unloading
Technical Data
Methods of Analysis

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